REPORT RESUMES

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EDUCATIONAL OF THE AURALLY HANDICAPPED--A PSYCHOLINGUISTIC ANALYSIS OF VISUAL COMMUNICATION.
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A PILOT STUDY WAS CONDUCTED TO DEFINE THE CHARACTER OF SPEECH MATERIAL IN VISUALLY PERCEPTUAL TERMS AND TO APPLY THE DEFINED CONCEPTS TO THE PROCESS OF INDUCED LANGUAGE ACQUISITION BY THE DEAF AND HARD-OF-HEARING. ITS PURPOSE WAS TO BUILD A CONCEPTUAL FOUNDATION FOR THE LATER DEVELOPMENT OF A COMPREHENSIVE RESEARCH PROGRAM, LEADING TO THE IMPROVEMENT OF LIPREADING TECHNIQUES AND OTHER METHODS OF TEACHING THE AURALLY HANDICAPPED. A LINGUISTIC MODEL WAS USED TO IMPLEMENT THE TWO PHASES OF THIS PRELIMINARY STUDY--(1) SPEECH PERCEPTION AND (2) LANGUAGE ACQUISITION. THE FIRST CONSISTED OF PREPARING A FILM TEST WITHOUT SOUND, HAVING APPROXIMATELY 200 MONOSYLLABIC ENGLISH NOUNS PRONOUNCED WITH A FULL-FACE VIEW AND A 45-DEGREE PROFILE VIEW FOR LIPREADING PURPOSES. IT WAS ADMINISTERED TO ABOUT 430 ADULT SUBJECTS DIVIDED INTO EXPERIMENTAL AND CONTROL GROUPS. ANOTHER FILM WAS ALSO PREPARED AND ADMINISTERED, USING NONSENSE SYLLABLES TO ASSIST THE SUBJECTS IN THE PERCEPTION OF THE INITIAL CONSONANTS. THE SECOND PHASE WAS A DESIGN PROJECT FOR A LONG-RANGE FOLLOWUP PROGRAM INVOLVING EDUCATION FOR DEAF CHILDREN. AS A MEANS OF DEVELOPING ELICITING PROCEDURES APPROPRIATE FOR PLANNING, A PILOT PERCEPTUAL DISCRIMINATION TEST WAS CONSTRUCTED AND GIVEN TO 21 NURSERY SCHOOL STUDENTS. (JH)

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1. INTRODUCTION

The investigation reported here was an 18-month pilot study designed for the development of a long-range research program to apply the theory and method of modern structural linguistics to problems concerning the visual perception of speech by aurally-handicapped individuals and the learning of language by preschool deaf children.

For the aurally-handicapped individual, visual speech reception (lipreading) is essential to communication in general, and to language acquisition in particular; education of the deaf, consequently, depends primarily on the development and transmission of adequate techniques of lipreading.

The immediate goal of this research, then, was a preliminary examination of the linguistic determinants of perception and learning in oral-visual communication, and in language development of the aurally-handicapped child. More specifically, the program has the following long-range objectives: (a) to develop a theoretical model of the structure of perception in lipreading, that is, a definition of the units of visual perception of oral-aural stimuli and of the relationships among these units in a system of oral-visual communication, and (b) to establish the relationship of the visually-perceived symbols to the underlying linguistic system.

It was planned that these objectives be implemented by a pilot study leading to a comprehensive research program in which the investigation would proceed according to two principal categories of analysis:

A. Communication techniques and perceptual processes

A definition of the character of the stimulus material (speech) in perceptual terms, with emphasis on visual speech reception (lipreading).

B. Education techniques and learning processes

An examination of the processes of induced language acquisition in the deaf child.

Constructed on the basis of linguistic theory and method, the general research design for the analysis of lipreading and language learning calls for a series of experiments to test the visual perception of the descriptive units of structural linguistics, beginning on the phonological level and proceeding later to morphology and syntax.

Because basic studies of the visual perceptibility of speech, and the nature of lip reading communication, are prerequisite to a solution of more specific educational problems of the deaf, the perception experiments have had chronological priority in the investigation, and have provided the basis and the conceptual units for formulating specific questions for the language acquisition study.

By following a linguistic model, it may be possible to determine the relationships between perceptual units of English speech and the analytic units of the English language, at successive levels of English structure. It was hoped that this general procedure would lead ultimately to isolating visual (and auditory) units of signal reception as compared to the signaling units in terms of which the code itself (the linguistic system) is structured; the definition of a decoding system based on visually received speech stimuli; and an assessment of the relative communicative efficiency of such a system.

As a general research design for both phases of the project, a model of analysis was constructed on the basis of linguistic theory. This model serves as a source of specific hypotheses, and English is the test language, in a series of experimental procedures in which the results of testing are classified linguistically and analyzed statistically.

As a working model, to be expanded and refined as the study progresses,[1] the following tentative levels and categories of analysis were adapted from linguistics for lip reading research:

1. PHONOLOGICAL

   a. Phonetic - the visibility of physiological articulations and of the differences among them.

   b. Phonemic - the visual perception of phonemes-- i.e., the lipreader's interpretation of the visible articulatory differences, relative to the aurally perceptible contrasts basic to the English phonetic system.

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[1] The general research program discussed here is to be continued for a three-year period with the support of funds from the Office of Education, Department of Health, Education, and Welfare.

c. Syllabic - the effect of syllable structure in the visual perception of speech--i.e., the selectivity which may operate in terms of the different consonantal-vocalic combinations permissible in English phonology.

(Experimentally, this problem is simply an extension of those outlined above for a. and b., providing more varied environments which are controlled, however, for the phonetic-phonemic levels).

d. Morphophonemic - visual perception in terms of morphologically determined phonetic alternation.

(This area of investigation is, on the one hand, an extension which increases environmental variation for perceptual units--this time to include morphological criteria--and on the other, a link between the phonological and grammatical levels of analysis).

2. GRAMMATICAL

   a. Morphological

   b. Syntactic

3. LEXICAL

   a. Context

   b. Metaphorical extension

Because a definition of the higher-order units in the analytic model depend largely on results of testing at lower levels of structure, grammatical and lexical areas have been indicated only schematically. The entire linguistically-based framework is of course, subject to constant revision in terms of problems specific to lip reading.

2. RELATED RESEARCH

Earlier research at the John Tracy Clinic, from which the current project was developed, has been described in Mary F. Woodward, *Linguistic Methodology in Lip Reading Research: An Experiment in Applied Psycholinguistics*, Ph.D. dissertation, University of California, Los Angeles, 1958. A preliminary report was published as No. IV in *John Tracy Clinic Research Papers* (Woodward, 1957), and this pilot experiment has also been described in a paper scheduled for publication in the *Journal of Speech and Hearing Research* (Woodward and Barber, 1960).

Other investigators have recently begun to apply certain linguistic concepts and methods in education programs for people with speech and hearing disorders (e.g., Albright and Albright, 1958, and Hutton, 1959). Although the work which these articles describe is complementary to the Cooperative Research Project reported here, there appear to be no other studies utilizing linguistic analysis for an investigation of lipreading processes.[2]

Structural linguists have not generally been concerned with the perceptual aspects of speech, an area which can be approached only with comparative and experimental data on different types of sensory reception. Although students of the interdisciplinary field of psycholinguistics have posed related questions (e.g., Osgood, 1954), none of these has focussed on problems of speech perception in the aurally handicapped.

In education, the application of linguistic methods has been limited primarily to the teaching of foreign languages (cf. Haas, 1953 and Whorf, 1949); otherwise, techniques and knowledge acquired during the past thirty years of development in linguistic science have been felt only sporadically in language arts teaching. In his survey, "Language Development in Children," John B. Carroll states:

> ....one of the most important methodolical considerations is a scientific conception of the nature of language in general and of the characteristics of the particular language or languages involved in any investigation.

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[2] An extensive bibliography of lipreading research has been prepared at the John Tracy Clinic (Wong, Dickens, and Taaffe, 1957).

> Psychologists and educators investigating child language have generally failed to take account of advances in linguistic studies; by the same token, linguists who have studied child language have missed many opportunities for interpreting their observations in psychological terms. Psychologists should give more consideration to the linguists' units of analysis (phoneme, morpheme, etc.)[3]

Beyond the general lack of interdisciplinary cooperation for applied research in this particular educational area, linguistic theory and data have not thus far been applied to problems of acquisition of a native language in situations where normal channels of learning (e.g., hearing) are not available.

Much material relevant to the research reported here may be found in the considerable literature on language development of normal children, but its value here is primarily for comparative purposes; psychologists and educators, as mentioned above, have not conducted their studies in linguistic terms. The normative measures of articulation, sound discrimination, sentence structure, and vocabulary found in Mildred C. Templin's Certain Language Skills in Children (1957) have so far provided the best, if not the only, comparative data for this program. Problems of translation into linguistic units and concepts, however, are present in this as well as in other sources.

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[3] Prepared for the 1960 edition of the Encyclopedia of Educational Research.

3. SPEECH PERCEPTION STUDY - FILM TEST II

EXPERIMENTAL DESIGN

The experimental design will be discussed according to the following outline:

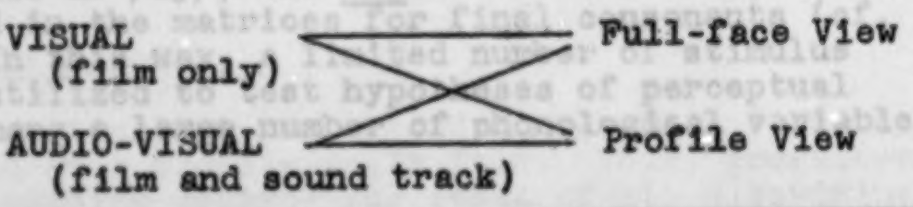
Part	
One:	Experimental Procedures
Two:	Classification of Variables
Three:	Classification of Hypotheses
Four:	Classification of Stimulus Materials

It should be noted that the numbers identifying categories and sub-categories of the hypotheses (Part Three) and the stimuli (Port Four) refer to corresponding numbers in the classification of variables (Part Two). This system of cross-reference was also followed in compiling a catalogue of stimulus materials for film production and for analysis of responses.

Part One: Experimental Procedures

Test II of the experimental series in linguistic perception was recorded on black and white film at two camera angles: a full-face view of the speaker, and a 45-degree profile angle. To allow for complete intersection of control variables, both view-experimental and view-control films were recorded with sound.

As a result of these recording methods, it was possible to present the Film Test under five stimulus conditions:


VISUAL
(film only)
Full-face View
AUDIO-VISUAL
(film and sound track)
Profile View

AUDITORY (sound track only)

The total length of the test was limited to 30 minutes including filmed instructions and a sample stimulus-response unit. Intervals for the recording of responses were edited into the film, and did not impose any requirements of timing on the speaker.

A film script was prepared from a randomized order of the 198 stimulus units selected for the experiment (see Appendix A). Stimuli were presented as discrete monosyllabic utterances, and each occurred only once in the test. The stimulus utterances were preceded by numbers in the film, and corresponding numbers appeared on the answer sheets to facilitate recording of responses.

The cover pages for answer sheets (see Appendix B) duplicated and expanded the filmed instructions for the experimental task, and also provided space for relevant personal data; (subjects were classified for differential age, sex, native language, degree and duration of hearing loss, if any, and impairment of vision). The task of the subject in the basic form of the test[4] was to write the stimulus word as he perceived it, using conventional English spelling to record his responses.

In accordance with estimates given in the proposal, the Film Test was administered to 428 subjects. The core population for both experimental and control groups at this test level consisted of adult normal-hearing speakers of English. Subjects were drawn primarily from university classes in the Los Angeles and Berkeley areas. Two copies of the films were made to allow for concurrent administration of the test in both areas.

It was planned that analysis of data for the basic form of the test cutlined above should begin with the construction of confusion matrices for comparison of responses *in terms of the phonemic components of the stimulus units*. That is, any one confusion matrix is concerned only with a single position of the formlae of phonological structure represented in the stimulus materials. If the stimulus unit *bit*, for example, elicits the response *bean*, the matrix comparing vocalic nuclei would show that /i/ had been perceived once as /iy/; the *t-n* confusion would, of course, be tabulated in the matrices for final consonants (cf. Table 5). In this way, a limited number of stimulus units were utilized to test hypotheses of perceptual relations among a large number of phonological variables.

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[4] It should be noted that given serial presentation of discrete stimulus units, a number of test variations can be achieved simply by use of different instructions and answer sheets. One such variation already planned for examination of certain paired relations of specific phoentic difference is to present the subject with a two-way choice of responses for each of two stimuli; (e.g., 1. beat ___ bit _X_ .... 29. beat _X_ bit ___).

Part Two: Classification of Variables

Test I of the Linguistic Perception series was limited in variables to the phonetic dimensions which define consonant-initial allophones of English phonemes in a constant vocalic environment (-a.) and a single lexical environment (zero). Test II, on the other hand, introduced a number of controlled phonological variables using actual items of English vocabulary.

Stimuli for Test II consisted of uninflected monosyllabic English nouns, selected according to the structural formulae CVC and (C)CCVC, where the C-position may be filled by a consonant, including zero and semi-vowels, and where V = vowel or V + semi-vowel.[5] Thus, morphological type and complexity were controlled, and though the stimulus units varied lexically, grammatical meaning was held constant. It should be noted that use of the zero consonant position in the formulae for Test II has the effect of allowing comparisons between consonants and vowels as well as among the different vocalic nuclei included in the stimulus materials.

It was estimated that the 198 stimulus items, presented at the rate of 8 words per minute, would be adequate to test a number of hypotheses derived from the phonologically-defined variables outlined below. It should be noted that single lexical items, by virtue of various features of phonological structure, were utilized without repetition to test several different hypotheses.

This experiment may be viewed as consisting of the following six sub-tests which conform to the phonological and morphological criteria selected for stimulus units:

I. View-Angle Hypothesis

The entire test was recorded both as a full-face view film and as a profile-angle film. Thus, profile-view was a cross-cutting control for tests of all discriminations and, in addition, a restricted variable for a specific view-angle hypothesis of crucial phonetic relationships:

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[5] All formulae for stimulus selection for Film Test II were derived from the Structural Formula of the Monosyllabic Word in Standard Midwestern American English (Whorf, 1949, Fig. 1, p. 8.)

It is conventional, in education of the deaf, to recommend a full-face view of the speaker for maximum lipreading efficiency. Certain items in the literature devoted to lipreading training reflect, at the same time, an opinion that alveo-palatal and interdental spirants are among the most highly visible articulations of English speech.[6] Pilot Study results from stimuli controlled for all but articulatory variation, however, indicated that one of these traditionally-held notions must be innaccurate or, at the very least, misleading.

As a technique to test the reliability of these conflicting assertions, it was hypothesized that given a partial profile view of the speaker, the alveo-palatal consonants (c, j, s, y) and the slit dental spirants (θ and ð) would attain visually-contrastive scores when paired with non-homorganic, non-homotypical articulations. These consonnants did not participate in such contrastive sets when presented as face-on visual stimuli (see Table 1). The specific hypothesis is presented as a visibility chart, Table 2.

An adequate test of this hypothesis (given, in addition, certain controls in the stimulus materials themselves) required two simultaneously filmed tests--one providing a full-face view of the speaker comparable to that assumed for the Pilot Study, and the other showing a profile view of 45 degrees.

Thus, Test II consisted of two parts: a view-experimental film and a view-control film, both of which were exposed at a single presentation of test materials, with variant angle controlled by camera positions. Other technical aspects of the film (e.g., lighting) were constant for both views, and duplicated pilot film conditions insofar as possible.

A. Alveo-Palatal Consonants

Because consonant-initial phonations involving labial articulation had already been established as visually contrastive with alveo-palatal consonants, it was necessary only that stimulus materials for this section of the test compare alveo-palatals with: (1) alveolars, (2) dentals, and (3) velars.

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[6] The following quotation exemplifies this view: "...the movements of the lips for 'f' and 'v' and that of the tongue for 'th' are like traffic lights for a good lipreader." Sonotone Corporation, 1941, p. 24.

TABLE 1

PERCEPTIBILITY OF DIFFERENCE AMONG CONSONANT INITIAL ALLOPHONES AS VISUAL STIMULI

LABIAL		NON-LABIAL		
Bilabial	p	t	č	k
	b	d	ǰ	g
	m	n		
		l		
Rounded	ʍ	s	š	h
	w	z	ž	
	r		y	ø
Labio-dental	f	θ		
	v	ð		

KEY (visibility of difference):

Contrastive (———)
Similar (------)
Equivalent ( )

B. Dental Spirants

Dental spirants, on the other hand, had shown ambiguous visual relationships with both labial and alveolar articulations. A test of these consonants, then, required stimuli comparing θ- and ð- with (1) labio-dentals, (2) alveolars and (3) velars.

The comparison of dentals and alveo-palatals is covered under A-2 above.

C. Variant Articulation Type

If it is postulated that alveo-palatal consonants are visually distinct from alveolars, then there is also

TABLE 2

POSTULATED VISIBILITY OF DIFFERENCE AMONG CONSONANT-INITIAL ALLOPHONES AS PROFILE-VIEW STIMULI*

Labial	Alveo-Palatal	Alveolar, Dental	Velar, Glottal
p-	č-	t-	k-
b-	ǰ	d-	g-
m-		n-	
		l-	
(W-)	š-	s-	h-
w-	(ž-)	z-	
r-	y-		ø-
f-		θ-	
v-		ð-	

a possibility for visually-contrastive relations among the three articulatory types of the alveo-palatal group itself, viz., the affricates (č-ǰ), the spirants (š-ž), and the semi-vowel (y-). As an example, if č- is visually distinct from t-, and š- is visually distinct from t-, then it may reasonably be expected that č- and š- are also visually distinct from each other. Reducing it to phonetic components based on points of articulation, we may symbolise /č/ as [t + š]. By the same token, of course, if s- is distinctive from both š- and y-, then y- may be expected to be discriminated from š-.

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*z- could not be included as a syllable-initial consonant in stimuli for Film Test II since it does not occur in this position in actual lexical items of English. Voiceless W- (not relevant to this hypothesis) was tested with CC-clusters (Cf. f.n. 7).

Stimulus materials for the specific aspects of the view-angle hypothesis, then, also included comparisons among the three sub-units of the alveo-palatal consonant initials: (1) affricate-spirant, (2) spirant-semi-vowel, and (3) affricate-semi-vowel.

II. Differential Perceptibility of Vocalic Nuclei

The proposed film test was also designed to determine perceptual differences among English vowels. This sub-experiment had objectives similar to those of the Pilot Study of consonant discrimination.

Because the perceptual contrastiveness of vocalic phonemes had not been established, it was necessary to maintain contextual controls in this part of the test which are comparable to those imposed in the consonant study. The principal experimental requirement, in these terms, was that vocalic stimuli be presented in minimally-distinctive environments.

Because we were dealing now with words rather than nonsense syllables, it was impossible to select large sets of lexical items which are minimally-distinctive in analytic terms. In order to simplify the assessment of comparative data from auditory and audio-visual control groups, the criterion of minimal analytic distinctiveness was followed insofar as possible; to complete the test sets, however, minimally-different environments were defined in terms of the homophenous units derived in the Pilot Study.

TABLE 3

VOWEL CHART

Tongue-(Lip) Positions	FRONT (Extended)	CENTRAL (Extended)	BACK (Rounded)
HIGH	iy		uw
	i		u
MID	ey		ow
		ay	aw
	e	e	
			oy
LOW	ä	a	o

A. The following formula was used to select one complete minimal set: bilabial C -V- postlabial C.

B. A small number of intersecting sub-sets were based on the several variables outlined in Table 3.

Perceptibility of the articulatory differences among the seven simple vowels and the seven diphthongs (V + SV) which comprise the vocalic nuclei of Standard Midwestern American English was tested in terms of the phonetic dimensions of the vocalic system; Table 3 classifies the 14 vowel nuclei according to the significant articulatory dimensions.

III. Differential Perceptibility of Consonant Initial Allophones in Variant Vocalic Environments

Because Pilot Study results were obtained by presenting consonant stimuli in a single phonetic environment, the visual units derived in that study were tested as consonant initials in differently-defined vocalic environments.

Perceptibility of the following Visually-Equivalent groups of analytic units (cf. Table 1) was retested in initial position preceding various vowel nuclei:

Bilabial	p-b-m
Rounded labial[7]	w- r-
Labio-dental	f-v
Dental	θ-ð
Alveolar	t-d-n-l s-z
Alveo-palatal	č-ǰ-ž y-
Velar	k-g h- ŋ-

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[7] Because the syllable-structure formulae followed in Test II allowed for initial consonant clusters, the unit W- of the pilot experiment was re-defined as an hw-cluster, and is listed in that section of the report (see Sec. IV).

These units proved to be Contrastive or Similar (i.e., non-equivalent) when presented as visual stimuli preceding a low central vowel (-a·). Section III of the present expirement was designed to provide additional environments defined by the following points along the principal dimensions of vocalic articulation (cf. Table 3, Vowel Chart):

A. High front vowel /iy/

(B. High back vowel /uw, u/
(C. Low back vowel /ɔ/

D. Mid-central vowel /ə/

IV. Differential Perceptibility of Consonant-Initial Clusters

Section IV of the present experiment was designed to test perceptual differences among English consonant phonemes in the (C)CC-position of monosyllabic words, *viz.*, where the consonant occurs as a constituent of a syllable-initial bi-consonantal or tri-consonantal cluster.

Maintenance of experimental controls for this phonological variable required minimally-different sets of stimulus words, selected in terms of the formulae:

$C_1C_2V_1C_3$		plain	/ pleyn /
$C_1V_1C_3$	e.g.	pane	/ peyn /
$C_2V_1C_3$		lane	/ leyn /

The cross-cutting variable of vowel environment (cf. Sections III and V) was also controlled by selection of a number of stimulus sets with syllabic units defined by the phonetic dimensions of the several vocalic nuclei.

Each (C)C_1C_2-cluster was not compared with every other C_1C_2-cluster and with (s), C_1, and C_2 initials, but the specific paired relations tested by the formulae were selected to be representative of all relevant consonantic dimensions. The selection was also based on the homophenous unit to which the initial member of the CC-cluster belongs according to Test I results.

The 36 English CC-initial and 8 (s)CC-clusters are summarized in Table 4--according to the classificatory order of C-initial allophones established by the hypotheses and results of the Pilot Study (cf. Table 1). Though for

TABLE 4

(C)CC-CLUSTERS

		Second Member									
		p	m	w	r	f	t	n	l	y	k
First Member	p				(s)pr-				(s)pl-	(s)py-	
	b				br-				bl-	by-	
	m									my-	
	f				fr-				fl-	fy-	
	v									vy-	
	θ			θw-	θr-						
	t			tw-	(s)tr-						
	d			dw-	dr-						
	s	sp-	sm-	sw-		sf-	st-	sn-	sl-		sk-
	š				šr-						
	k			(s)kw-	(s)kr-				(s)kl-	(s)ky-	
	g			gw-	gr-				gl-	gy-	
	h			hw-						hy-	

sake of completeness, Table 4 shows all possible initial (s)CC-combinations for the English monosyllabic word (cf. Whorf, 1949, Fig. 1, p. 8) not all clusters will fit the framework set up for Film Test II; *gw-*, for example, occurs only in proper names (e.g., *Gwen*).

V. Differential Visibility of Consonant-Final Allophones

Because actualizations of English consonant phonemes in word-final position show articulatory features which differ from those characteristic of consonant-initial allophones, the patterns of phonetic difference which distinguish these phonemes in final position may have a different structure of perceptual correlates than that suggested by the pilot experiemnt.

One section of Film Test II, then, was devoted to examining dimensions of perceptual difference among final allophones of English consonants. A general hypothesis of these relationships, for visual conditions of reception, is summarized in Table 5.

Though stimulus selection was based in part on the results of Test I, environmentally-determined differences of articulation made it necessary to re-investigate visual relationships among some of the analytic units which comprise the homophenous sets of syllable initials. Phonological variables for Section V, then, included certain dimensions of difference among consonant phonemes which proved non-significant in the visual discrimination of consonant-initial allophones.

A. Homorganic Sets

Area of articulation is the crucial dimension of visual difference among initial consonants, and Pilot Study results had demonstrated that there are no visually-perceptible cues to the analytic differences among homorganic sets of voiceless-voiced stops and continuants (e.g., p-b-m). It is possible, however, that in final position phonetic features redundant to the basic criteria of voicing and articulation type may prove available to visual observation.

Variation in length of a medial vowel, for example, is a partial function of the phonetic character of the following consonant-final. Consider the minimal set: *rip*, *rib*, *rim* where phonemic difference is expressed only in the final consonant position. As a function of the single phonemic difference, however, the minimal set exemplifies three phonetically-different forms (allophones) of the vocalic unit /i/. *rip* contains the shortest and *rim* the longest variety of the vowel (of the three forms given in this particular example).[8] Phonetically, a still greater difference may be attributed to the *-VC* portion of *rim*, by virtue of the length of the continuant consonant itself.

Though it was not considered likely that each of the separate gradations of vowel length (or combined *-VC* length) would render the differences among consonantal articulations visually perceptible to the *untrained lipreader*, it is quite possible that the greater length differences (e.g., those between *-Vp* and *-Vm*) are potentially-visible correlates to phonemic distinctions among final consonants. Given stimuli to test analytic contrasts deriving from the combined criteria of voice and articulation type, then, it was felt that any results differing from those of Test I should at least suggest directions for further study and, perhaps, for the development of special teaching techniques.

B. Variant Forms of the r-Phoneme

Perhaps the greatest visible difference in articulation between initial and final actualizations of English consonant phonemes is shown by the relevant allophones of /r/. The high visibility rating attained by this consonant in the pilot experiemnt is attributable to the lip rounding which is characteristic of word-initial *r-*. Even in those dialects of English which include a final *-r*, however, the labial feature is lacking in this position. On this basis, word-final *-r* was placed with the alveolar consonants for the purpose of assessing homophenous relationships among consonant finals (cf. Table 5). In terms of this reclassification, final *-r* was to be compared with the partially homophenous units of initial position (w-, f-v), as well as with the post-labial consonants which were visually distinctive from *r-* initially.

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[8] Actually, there are at least five phonetically-determined variations in the length of simple vowel nuclei in the pre-final-consonant environments of a stressed syllable. Duration varies from short to successively-longer in a position preceding the following consonantal articulation types: (1) voiceless stop (p), (2) voiceless spirant (f), (3) voiced stop (b), (4) continuant (m), and (5) voiced spirant (v). (c.f. Trager and Smith, 1951, Section 1.1 and 1.2). Because we are concerned only with homorganic sets, however, stimulus selection for Film Test II depended for the most part on varieties (1), (3), and (4)--those exemplified in the p-b-m set above.

C. Relative Visibility of Final Allophones of all Consonants

Because of the nature of the conditioned variations in consonantal articulation in final position, the relative visibility of phonation postulated for final consonants (Table 5) shows greater differentiation among analytic units than that derived in tests of consonant-initial allophones (Table 1).

Including stimuli selected specifically to test perceptual relations within homorganic sets, then, and between *-r* and other consonants, Film Test II was designed for comparisons of all the phonemic dimensions which define analytic differences among English consonants. Stimulus materials for this section of the experiment, then, included examples of all final consonants, or of all dimensions of consonantal contrast in final position.

VI. Re-test of Inconsistent Visual Units

Section VI of the proposed experiment was devoted to a re-examination of phonological variables for which earlier testing resulted in ambiguous categories, *viz.*, the following unequally-differentiated units of visual perception (cf. Table 1):

A. (W)-w/r

B. r/f-v

C. f-v/θ-ð

A limited administration of Film Test I, under conditions which differed from those followed in the Pilot Study,[9] had indicated that experimental procedures and analytic techniques of Test II should reveal a clearer picture of the relationships among these articulatory dimensions than that afforded by the dichotomous-choice pattern utilized in earlier testing.

Adoption of these procedures, however, depended on the use of actual lexical items as stimuli. Given a phonemic transcription of stimulus materials--in the dialect of the informant appearing in the film--it was felt that conventional English orthography would be adequate, in most cases, for identifying and comparing the responses phonemically.

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[9] The test was administered to two subject with considerable experience in structural linguistics (John B. Carroll, Harvard University, and C. G. Barber, John Tracy Clinic). Their task was not to respond to the syllable pairs as "alike" or "different" (as in the pilot experiment), but to identify *per se* the consonant-initial phonemes of of each syllable.

TABLE 5

POSTULATED VISIBILITY OF DIFFERENCE
AMONG CONSONANT-FINAL ALLOPHONES

ARTICULATION TYPE		AREA OF ARTICULATION				
		Labial	Dental	Alveolar	Alveo-Palatal	Velar, Glottal
Stops and Affricates	Vl.	-p		-t	-č	-k
	Vd.	-b		-d	-ǰ	-g
Continuants		-m		-n -l		-ŋ
Spirants	Vl.	-f	-θ	-s	-š	
	Vd.	-v	-đ	-z	-ž	
Semi-Vowels*		-w		-r	-y	-ø

*It should be noted that although they function as components of complex vocalic nuclei (cf. Sec. II and Table 3), final -w and -y are allophones of phonemes whose initial variants are consonantic in function. For a systematic set of comparisons, then, -w and -y must be included with other consonants in a test of perception of final allophones.

Certain of the phonetic relationships to be investigated in the second test of the experimental series required that -w and -y be considered a part of the syllabic nucleus of the stimulus unit, whereas other comparisons required their treatment as final-consonant allophones.

The zero-consonant position is a device for handling this variation consistently, as well as a substitute designation for the mid-central glide which Trager and Smith phonemicize as a final h-allophone comparable to -w and -y (1951, Secs. 1.23 and 1.32). a and ɔ are the only simple vowels of Midwestern English which occur in the so-called h-environment in final open syllables--i.e. without vocalic dipthongization (-w, -y) or other final consonant.

The selection of English vocabulary items as stimuli would also permit the construction of matrices which show the direction of perceptual confusion among the relevant phonetic dimensions. By these procedures the unequally-different categories under investigation should be eliminated or explained.

Specific reference to Pilot Study results, however, meant that stimulus materials selected to check the questionable consonant relations should include the -a· environment of Test I. Because not all the crucial consonants occur contrastively in this particular environment, this part of the experiment was to be supplemented by data from a second nonsense-syllable test (Film Test III, q.v.).

Part Three: Classification of Hypotheses

A set of specific hypotheses, derived from the above discussion of the variables for Test II, are outlined below by corresponding numbers. It should be emphasized that the various hypothetical findings concerning visual contrastiveness, similarity, and equivalence of phonemes were meant to apply only to the responses of subjects to the discrete monosyllabic utterances used as stimuli. While it was anticipated that many of the postulated relationships have much wider application, it could not be an automatic assumption.

I. View-Angle Hypothesis

One hypothesis specifying the relevance of view-angle for the visual perception of particular groups of consonant phonemes was presented in the classification of variables (see Table 2). In addition, because the entire test was filmed with a profile view of the speaker, as well as a full-face view, profile view was a cross-cutting variable for tests of all discriminations, and is referred to below wherever it is considered relevant for visual perception.

II. Differential Perceptibility of Vocalic Nuclei

It was postulated that the most important articulatory dimension for the visual perception of vowels and diphthongs (see Table 3) is the factor of lip position, i.e., whether the lips are extended or rounded. Thus, the vocalic nuclei of English monosyllabic words presented in isolation may be divided immediately into two-visually contrastive groups (the classification includes diphthongs on the basis of lip position of the final element):

Extended: iy i ey e ɨ ə a ɔy

Rounded: aw u/ u ow ɔ

This grouping corresponds to a grouping based on tongue position, since front and central vowels are extended, while back vowels are rounded.

Further discrimination is possible on the basis of the changes of lip and tongue position during articulation, i.e., whether simple vowels or diphthongs are involved. The diphthongs, in turn, may be subdivided according to the amount of movement involved in the changes of position of lips (and of the tongue, along the front-central-back continuum):

		TONGUE POSITION (Front to Back)	
		Changed	Unchanged
LIP POSITION	Changed	aw ɔy	
	Unchanged	ay	iy ey uw ow

The diphthongs -aw- (extended to rounded; central to back) and - y- (rounded to extended; back to front) show the greatest amount of positional change in the above terms; they also demonstrate changes in tongue position from low to high, or high to higher, along the latter dimension. It was postulated, therefore, that -aw- and - y- would be visually contrastive with all other vocalic nuclei (and with each other), while the remaining diphthongs would be visually similar to the simple vowels.

Primarily on the basis of lip position, four visually-contrastive units of vocalic articulation were distinguished hypothetically;

(i) Extended: iy i ey e ɨ ay ə a

(ii) Rounded: uw u ow ɔ

(iii) Extended to rounded: aw

(iv) Rounded to extended: ɔy

Within the groups containing more than one analytic member (i) and (ii), discrimination may be made in terms of tongue position from high to low. This perceptual distinction is relatively less precise, however, than that based on lip position, since it is not as visible, and since it does not provide two clear-cut groupings. It was postulated, therefore, that overlapping sets of visually-similar vowel nuclei would be found in test responses.

More specifically, it was assumed that vocalic nuclei in Groups (i) and (ii) would be confused with vowels adjacent to them in tongue height, as well as with vowels adjacent to their immediate neighbors along this continuum. While it was expected that the number of correct responses to a given vocalic stimulus of these categories might not equal the total number of near-missed responses, the number of correct responses should be greater than that for any specific incorrect response. For example,responses to -iy- would include perceptions as -iy-, -i-, and -ey- on a diminishing scale; in turn, responses to -i-, besides correct perceptions, would include -iy- and -ey- and, less extensively, -e-. It was doubtful, of course, that such a neat picture would emerge for every vocalic nucleus, either for range or degree of confusion. For the non-reciprocal relationships between front and central vowels, adjacency was viewed in horizontal as well as vertical terms, and a greater range of confusion was postulated, comparable to that for -ay-.

A schematic representation in the form of a confusion matrix (Table 6) indicates the picture of results which was postulated for responses to the discrete items of the test. It should be emphasized again that such an overall comparison depends on the presentation of the several vocalic nuclei in a constant phonetic environment, since it is possible that certain final consonants (e.g., -r and nonlabial continuants -n, -l, and -ŋ) may be partially confused with vowel nuclei, while other final consonants (including -Ø)may also have an effect on the perception of the preceding vowels.

III. Consonant Initial Allophones in Variant Vocalic Environments

The classification of consonant-initial allophones into contrastive, similar, and equivalent sets on the basis of data from Film Test I (see Table 1) required checking in terms of different vocalic environments for the initial consonants. Since the environment presented in the former test was held constant by use of the low central vowel -a·, groups derived from the earlier experiment were to be presented in Test II with other vocalic nuclei. These were selected to provide a range of environments, e.g., high front vowel -iy,

TABLE 6

POSTULATED VISUAL CONFUSIONS AMONG VOCALIC NUCLEI

RESPONSE

STIMULUS	iy	i	ey	e	ä	ay	ə	a	oy	aw	uw	u	ow	ɔ
iy	+	+	+			+								
i	+	+	+	+		+								
ey	+	+	+	+	+	+								
e		+	+	+	+	+								
ä			+	+	+	+								
ay	+	+	+	+	+	+								
ə	+	+	+	+	+	+	+	+						
a		+	+	+	+	+	+	+						
oy									+					
aw										+				
uw											+	+	+	
u											+	+	+	+
ow											+	+	+	+
ɔ												+	+	+

+ = Postulated response

Double lines separate visually contrastive groups back vowels -uw-, -u, and - , and mid-central vowel - . Though this procedure is experimentally and analytically desirable, it was postulated that alteration of vocalic environments would have no significant effect on the visually-equivalent units already established.

IV. Differential Perceptibility of Consonant-Initial Clusters

A consideration of the visual perceptibility of the initial clusters found in monosyllabic words required an examination of the relationships between individual consituents before any hypotheses of relative ease or difficulty of perception could be formulated. Since the relative visibility of initial consonants had been tentatively determined (see Table 1), and was to be rechecked in different vocalic environments in the present test, it was a logical next step to examine the effect of a following consonant on an initial consonant. After investigating this relationship, the question of the influence of the first consonant on the perception of the second could be considered. Only then could the relative visibility of the clusters per se, in comparison with single consonant initials be considered.

Initial Consonants

There are 13 consonants in English which take the first position in initial clusters (p, b, m, f, v, t, d, θ, s, s, k, g, and h). These consonants occur before a class of four second-position constituents (w, r, y, and l). This distribution is tabulated in the cluster chart (Table 4) which indicates the specific combinations occurring. In addition to -w and -l, s- may also precede six other consonants (-p, -m, -f, -t, -n, and -k), any p- or k- cluster, or tr-. Because of the special nature of these s-clusters, they are considered separately below.

For the group of clusters discussed above, it was postulated that the presence of -w, -r, -l, and -y would have no effect on the perception of the preceding consonant initial. In other words, visually-contrastive units established in the earlier test would not be disturbed by the occurrence of 13 of the consonants as initial members of clusters, nor would the perceptibility of these 13 consonants be aided or hindered by this variation in environment. This postulation was in close agreement with the hypothesis concerning the effect of variant vocalic environment on perception of initial consonants, and it may be justified logically by the fact that two of the consonants in question are semi-vowels (-w and -y), while the other two (-r and -l) are liquids.

Second-Position Consonants

Omitting consonants which appear only after s-, the perceptibility of -w, -r, -l and -y as the second members of clusters may now be considered. Because -r is not characterised by the lip rounding of initial r-, it was assumed that it would not enter into a visually-contrastive group with -w (as it did initially), but that it would probably demonstrate visual similarity with members of the large group of non-labial consonants. It was felt, however, that the semivowels and -l would probably retain their respective relationships with other consonants. It was postulated, therefore, that perception of the four consonants which may fill the second position in more than one cluster would be equivalent to their perception in final position (see Table 5).

Clusters with s-

This category was based on the fact that six consonants may follow no other consonant than s- in initial clusters, and further, that the only tri-consonantal initial clusters in English begin with s-. The permissible combinations are summarized in Table 4.

It was postulated (Sec. IV-A) that s- before -l and -w (as with the other initial consonants) would be neither easier nor harder to perceive than when it appears alone initially. The same assumption was made for s- before -t, -n, and -k. With regard to the s-clusters with bilabial or labio-dental second members, it is possible that any visible lip movements before the labial closure may be taken as s-, since this is the only phoneme which can appear in this position in a monosyllabic word. Because no specific effects of redundancy were hypothesised for the cumulatively-limited possibilities of English structure, however, it was postulated, in the form of a null hypothesis, that s- before other consonants would not be visually contrastive with other non-labial consonants.

Turning to a consideration of the second members of bi-consonantal s-clusters (-p, -m, -w, -f, -n, -l, and -k), there appeared to be no reason for assuming differences in perceptibility other than those which had been discovered or postulated for their respective initial and final allophones. The relevant allophones of these particular consonants show, in some cases, greater resemblances to the initial allophones, and in other cases, to the finals. However, since none of the phonetic differences involved indicates any changes in degree of visual perceptibility, and since the same conclusions were reached with regard to the initial and final allophones of these eight consonants, it was postulated that they would fall into the same visually similar and contrastive groups as before (p-m, w, f, t-d-n, k).

The additional complication of the tri-consonantal clusters (only five of which appear in common monosyllabic nouns: spr-, spl-, str-, skw-, and skr-) were dealt with in terms of the corresponding bi-consonantal clusters (pr-, pl-, tr-, kw-, and kr-). Thus, consideration of -p-, -t-, and -k- may be referred to discussions both of initial p-, t-, and k-, and of the second members of clusters following s-. Remarks about -w, -r and -l as second members of clusters again apply.

Clusters as Units

Implications of the above assumptions about the relative visibility of individual constituents of clusters may be summarised as hypotheses of perceptibility for clusters as units.

It was postulated that if both members of a -w, -r, -l, or -y group cluster are characterized by some degree of labial involvement, the cluster itself may be correctly perceived--within the limits of the respective homophene classes. It should be noted, however, that this restriction applied only to clusters with -y (py-, my-, fy-, vy-), which are limited in distribution to positions before -uw in a relatively small number of words, and these in turn, enter into only a few minimal sets. The redundancy which results from the limitation of structural possibilities, then, was considered a factor in perceptibility, especially since lip extension for y- did not prove contrastive in the earlier test.

For the remaining clusters, it was postulated that if only one consonant has noticeable lip movement in articulation--regardless of its position in the cluster--the cluster itself will be visually similar to the respective labial consonant (or its homophenes) appearing alone, and with any clusters of the same category, with the same labial consonant (or its homophenes). There is some justification for this in the visual equivalence of W- and w- as shown in Test I (although both were visually contrastive with h-). Since W- was now to be interpreted as hw-, the visual equivalence between hw- and w- indicated a high probability for the "masking" of a non-labial consonant by a labial articulation. It was felt that of this hypothesis is valid, an extremely large number of homophenous consonantal articulations would result.

For clusters composed of two non-labial constituents, difficulties of perception and discrimination appear so great that no hypotheses were formulated. It was not expected, however, that perception would be completely random, and it was hoped that subsequent analysis would provide leads to other possible means of discrimination.

For clusters beginning with *s-*, it was likewise postulated that *s*-clusters which include consonants of labial articulation (sp-, spl-, spr-, sm-, sf-, sw-, skw-) would be visually similar to the respective labial constituents appearing alone and in other clusters (see preceding paragraph). This hypothesis corresponds to the null hypothesis of the perceptibility of initial *s-* in clusters. For this reason, it should be emphasized that contradictory results in this area were not considered unlikely. Remarks made in the preceding paragraph apply to *s*-clusters containing no labial consonants and, with even greater strength, to the remaining tri-consonantal clusters (skl- and skr-).

V. Differential Visibility of Consonant-Final Allophones

The articulatory differences between initial and final allophones of various consonant phonemes have been discussed in the classification of variables (Part Two), and a general hypothesis of the relative visibility of difference among final allophones has been included as Table 5. This chart may be compared with Table 1, which summarizes earlier test results on consonant-initial allophones. In addition, comparison should be made with visibility of difference which was postulated for certain groups of consonants under profile-view conditions (Table 2). The same differences in differential visibility were postulated for the final and initial allophones of the relevant phonemes, the alveo-palatal and dental consonants.

VI. Re-Test of Inconsistent Visual Units

No specific hypotheses were formulated for examining the unequally-differentiated units derived in earlier testing: A. (W)-w/r; B. r/f-v; C. f-v/θ-ð. Nevertheless, stimulus materials consisting of minimal pairs for checking these discriminations were included and, as was mentioned earlier, it was hoped that the analytic procedures possible under experimental conditions for the new test would either eliminate or explain the unequally-different categories.

It may be noted, by reference to Table 2, that under profile-view conditions, it was postulated that while Group A (w-r) remains ambiguous, Groups B and C would form units which are visually contrastive; this definition eliminates the confusion between *r-* and *f-v*, on the one hand, and between *f-v* and *θ-ð* on the other. Group C, in fact, was to receive a specific check in the analysis of the view-angle hypothesis. It was also postulated that, regardless of view, the ambiguities noted initially in Groups A and B will not be found finally, because of the differences in articulation for *-r* as compared with *r-*. New ambiguities are not unlikely, however, in the tentative position granted *-r* in Table 5.

Part Four: Classification of Stimulus Materials

To clarify the phonetic relationships under consideration, stimulus units are given both in conventional English spelling and in phonemic transcription.

I. VIEW-ANGLE HYPOTHESIS (specific)

A. Alveo-Palatal Comparisons

1) Alveolars

shoe - zoo	/šuw - zuw/
yawn - dawn	/yɔn - dɔn/
job - shop - top	/ǰab - šap - tap/
chin - gin - shin - tin	/čin - ǰin - šin - tin/

2) Dentals

chum - thumb - (sum)	/čəm - θəm - səm/
chief - thief - (leaf)	/čiyf - θiyf - liyf/
yawn - thought	/yɔn - θɔt/

3) Velars

job - shop - cop	/ǰab - šap - kap/
cheer - year - gear - ear	/čir - yir - gir - ir/
shawl - yawn - call - hall	/sɔl - yɔn - kɔl - hɔl/

B. Dental Comparisons

1) Labials

thought - fawn	/θɔt - fɔn/
thing - fig - fin	/θiŋ - fig - fin/

I-B-2) Alveolars

thought - dawn - song	/θɔt - dɔn - sɔŋ/
thug - (rug) - tug	/θəg - ṛəg - təg/

3) Velars

thing - king	/θin - kiŋ/

C. Comparison of Articulatory Type

1) Affricate-Spirant

chin - shin	/čin - šin/
job - shop	/ǰab - šap/

2) Spirant--Semi-vowel

shawl - yawn	/sɔl - yɔn/
shoe - you	/šuw - yuw/

3) Affricate--Semi-vowel

cheer - year	/čir - yir/

II. DIFFERENTIAL PERCEPTIBILITY OF VOCALIC NUCLEI

A. Minimal Set: labial - V - postlabial

beet	/biyt/			boot	/buwt/
bit	/bit/	bite	/bayt/	book	/buk/
bait	/beyt/	bus	/bəs/	boat	/bowt/
bet	/bet/	pot	/pat/	boy	/bɔy0/
bat	/bät/	bout	/bawt/	boss	/bɔs/

II -B. Minimally Intersecting Sets

1) fVt

feed	/fiyd/			fool	/fuwl/
fin	/fin/	fight	/fayt/	foot	/fut/
fate	/feyt/	fudge	/fəǰ/	phone	/fown/
--		--		voice	/vɔys/
--		--		fawn	/fɔn/

2) tVp

team	/tiym/			tube	/tuwb/
--		type	/tayp/	--	
tape	/teyp/	sum	/səm/	--	
--		top	/tap/	--	
tab	/täb/	--		--	

3) hVt

--		--		hooch	/huwč/
hill	/hil/	--		hood	/hud/
--		--		--	
head	/hed/	--		oil	/ɔyl/
--		owl	/awl/	hall	/hɔl/

III. CONSONANT-INITIAL ALLOPHONES IN VARIANT VOCALIC ENVIRONMENT

A. High front vowel /iy/

beet - weed - reed - feed - seed	/biyt - wiyd - riyd - fiyd - siyd/
-- -- reef - thief - leaf	/ -- -- riyf - θiyf - liyf/

III-B. **High back vowel /uw, u/**

pool - rule - fool - tool	/puwl - ruwl - fuwl - tuwl/
book - wool	/buk - wul/

C. **Low back vowel /ɔ/**

boss-walk-fog-thought-talk-chalk	/bɔs - wɔk - fɔg - θɔt - tɔk - čɔk/

D. **Mid-central vowel /ə/**

bus - rug - fudge - thug - judge	/bəs - rəg - fəǰ - θəg - ǰəǰ/
-- -- -- -thumb-sum-chum-gum	/θəm - səm - čəm - gəm/

IV. DIFFERENTIAL PERCEPTIBILITY OF CONSONANT-INITIAL CLUSTERS

A. Comparison of C-Initial Clusters with the C-Initial Allophones of their Constituents: C_1C_2-C_1-C_2

1)	prose - pose - rose	/prowz - powz - rowz/
2)	blight - bite - light	/blayt - bayt - layt/
3)	butte - boot - you	/byuwt - buwt - yuw/
4)	freight - fate - rain	/freyt - feyt - reyn/
5)	flight - fight - light	/flayt - fayt - layt/
6)	fuel - fool - you	/fyuwl - fuwl - yuw/
7)	(θw - θ - w)	
8)	throng - thong - wrong	/θrɔŋ - θɔŋ - rɔŋ/
9)	twitch - ditch - witch	/twič - dič - wič/
10)	train - date - rain	/treyn - deyt - reyn/
11)	suite - seed - weed	/swiyt - siyd - wiyd/

IV-A-12) slide - light - sign /slayd - layt - sayn/

13) shred - shed - wreck /šred - šed - rek/

14) quake - cake - wake /kweyk - keyk - weyk/

15) grain - cane - rain /greyn - keyn - reyn/

16) click - kick - lick /klik - kik - lik/

17) cue - goose - you /kyuw - guws - yuw/

18) hue - hooch - you /hyuw - huwč - you/

B. Comparison of C-Initial Allophones in Variant C_2 Envirnnments

1) p-pr-pl-py-

-- - broom - bloom - -- -- - /bruwm - bluwm/

boot - brute - -- - butte /buwt - bruwt - -- - byuwt/

2) f-fr-fl-

fight - fright - flight /fayt - frayt - flayt/

3) (θ-θw-θr-)

4) t-tw-tr-

ditch - twitch - trick /dič - twič - trik/

5) k-kw-kr-kl-

gas - quack - grass - glass /gäs - kwäk - gräs - gläs/

6) (h-hw-hy-)

C. Comparison of C_2 Allophones in Variant C_1 Environments

1) w-tw-sw-kw-hw-

weed - tweed - suite - queen - wheat
/wiyd - twiyd - swiyt - kwiyn - kwiyt/

IV-C-2) r-pr-fr-θr-tr-šr-kr-

rain - -- - freight - -- train - -- - grain

/reyn - - freyt - -- treyn - -- - greyn/

wreck - bread - -- -thread - -- - shred - --

/rek - bred - -- -θred - -- - šred - --/

3) l-pl-fl-sl-kl-

light - blight - flight - -- - slide - -- - glide

/layt - blayt - flayt - -- - slayd- -- - glayd/

4) y-py-fy-ky-hy-

you - mule - fuel - cue - hue

/yuw - myuwl - fyuwl - kyuw - hyuw/

D. Comparisons of s-Clusters

1. sC-Clusters

a. Comparison of sC_2-Clusters with s- and C_2-initials: (sC_2-s-C_2)

1) speed - seed - beet /spiyd - siyd - biyt/

2) suite - seed - weed /swiyt - siyd - wiyd/

3) sphere - seer - fear - ear /sfir - sir - fir - ir/

4) steam - seam - team /stiym - siym - tiym/

slide - sign - light /slayd - sayn - layt/

5) ski - seed - key /skiy - siyd - kiy/

IV.-D-1-b. Comparison of s-initials in variant C_2 environments

1) seed - speed - suite - -- - sneeze - ski

/siyd - spiyd - swiyt - -- - sniyz - skiy/

2) seer - smear - -- - sphere - -- - --

/sir - smir - -- - sfir - -- - --/

3) -- - spool - -- - -- - stool - school

/-- - spuwl - -- - -- - stuwl - skuwl/

2. Comparison of sC_2C_3-Clusters with C_2C_3-, C_3-, sC_2-, s-, and C_2-Initials

spr-

spree - breed - reed - speed - seed - beet

/spriy - briyd - riyd - spiyd - siyd - biyt/

spl-

splice - blight - light - spine - sign - pile - eye - slide

/splays - blayt - layt - spayn - sayn - payl - ay - slayd/

str-

steam - dream - ream - steam - seam - team

/striym - driym - riym - stiym - siym - tiym/

skw-

squeeze - queen - weed - ski - seed - key - suite

/skwiyz - kwiyn - wiyd - skiy - siyd - kiy - swiyt/

skr

scream - cream - ream - scheme - seam

/skriym - kriym - riym - skiym - siym/

V. DIFFERENTIAL VISIBILITY OF CONSONANT-FINAL ALLOPHONES

A. Homorganic Sets

1) **-p-b-m**

nap - tab - lamb - /näp - täb - läm/

soup - tube - loom /suwp - tuwb - luwm/

2) **-t-d-n-l**

bit - bid - bin - bill /bit - bid - bin - bil/

coat - code - cone - coal /kowt - kowd - kown - kowl/

3) **-k-g-n**

wick - wig - wing /wik - wig - wiŋ/

talk - dog - song /tɔk - dɔg - sɔŋ/

B. Variant Forms of the r-Phoneme (-r/-w-f-alv)

car - cow - -- - cot /kar - kaw - -- - kat/

door - dough - loaf - load /dɔr - dow - lowf - lowd/

deer - -- - sieve - tin /dir - -- - siv - tin/

V-C. Dimensions of Difference among other Final Consonants

1) -p-f-θ-t-č-k

ream - reef - wreath - reed

/riym - riyf - riyθ - riyd/

room - roof - tooth - root - rouge

/ruwm - ruwf - tuwθ - ruwt - ruwž/

2) -t-s-z

bite - price - prize

/bayt - prays - prayz/

3) -d-s-z-č-ǰ-š

seed - niece - sneeze - leech - siege - leach

/siyd - niys - sniyz - liyč - siyǰ - liyš/

VI. RE-TEST OF INCONSISTENT VISUAL UNITS

A. (W)-w/r

weed - reed /wiyd - riyd/

wing - ring /wiŋ - riŋ/

witch - ridge /wič - riǰ/

B. r/f-v

reed - feed /riyd - fiyd/

rule - fool /ruwl - fuwl/

VI-C. f-v/θ-

fin - fig - thing	**/fin - fig - θiŋ/**
fog - thong	**/fɔg - θɔŋ/**
fawn - thought	**/fɔn - θɔt/**

RESULTS

The various forms of Film Test II were administered during May, June, and July, 1959, to 19 groups of university students in the Los Angeles and Berkely areas. In addition to these students, the subjects included two groups, totaling 13 and 19 respectively, at the John Tracy Clinic where the full-face and profile visual forms of the test were shown.

The total of 428 sets of responses obtained were distributed according to the following experimental and control conditions:

	N
Visual, full-face view	106
Visual, profile view	113
TOTAL, Experimental subjects	219
Audiovisual, full-face view	56
Audiovisual, profile view	53
Auditory	100
TOTAL, Control subject	209

A sample cover page for the answer sheets used in administering the visual forms of the test is included as Appendix B. While the cover pages for the audiovisual and auditory forms of the test had a different set of instructions, the personal data requested was the same. A summary of this information is included below:

	SEX		AGE	NATIVE LG.		HEARING		VISION	
GROUPS	M	F	Mean	Eng.	Other	Normal	H-H	Normal	Corrected
Visual (219)	55	164	25.9	211	8	213	6	133	86
Audio-visual (109)	60	49	24.2	102	7	106	3	79	30
Auditory (100)	54	46	26.0	98	2	93	7	68	32
TOTAL	169	259	25.1	411	17	412	16	280	148

The discussion which follows will be limited to the results obtained from the 219 subjects who took the visual forms of the test. While results from the audio-visual and auditory subjects have been tallied, there has been insufficient time for analysis; further, it is assumed that the visual data are of greater interest to educators of the deaf and all of the possibilities for analyzing this material have not yet been exhausted.

For both visual groups, the various responses to each of the 198 stimulus words in the test were tallied, transcribed phonemically, and then combined on data sheets (see Appendix E). These sheets did not include the specific words given as responses, but rather provide for a phonemic breakdown of all responses into initial consonants (including consonant clusters), medial vowels or vocalic nuclei, and final consonants. In addition, the sheets have spaces to indicate the number of usable responses, the number of rejected responses, and the total number of different words guessed.

The greatest number of rejected responses were simply omissions on the part of the subjects, but polysyllabic responses and ambiguous spellings (e.g. 'tear') were also included, since they could not be counted in the analysis. Nevertheless, the so-called rejects were broken down according to these categories since the figures may be used in the future for formulating certain indices of difficulty of visual perception. For the same reason, the total number of different words given as responses was tallied.

The range in usable responses was 44-100% for the full-face view, 46-100% for the profile view (for each view both the highest and lowest responses were to the same lexical items). The mean response for both views was 88%. The test results will now be discussed according to certain of the more important hypotheses given above in the section on experimental design.

I. VIEW ANGLE HYPOTHESIS

Some indication has just been given that significant differences were not discovered between the results of the full-face film and those of the profile film. It should be emphasized that "profile" here has reference to a 45 degree angle, not a complete side view. Not only were the range and mean for usable responses almost identical for both views, but differences in general were not great. For the profile film, 96 of the 198 items had a higher frequency; and 17 words had identical frequencies for the two views. This is, of course, only a rough measure, since these figures do not have reference to correct responses. Nevertheless, they agree quite strikingly with an independent investigation of the importance of facial view for lipreading.[10]

The view-angle hypothesis formulated for testing by Film Test II, however, had specific reference to certain groups of consonants which were confused visually in Film Test I (see Table 1). As summarized in Table 2, it was hypothesized that the alveo-palatal consonants (č, ǰ, š, y) and the dental spirants (θ, ð) would be visually contrastive with dental, alveolar and velar consonants under profile view conditions. Section I of the Classification of Stimulus Materials shows the specific pairs of words for which responses were to be compared; some of these comparisons will be presented below in the form of simplified confusion matrices.

In Table 7, response frequencies are presented for the initial consonants of groups of minimally-distinctive test items. Each group contains at least one word beginning with an alveopalatal consonant, although other comparisons may be found in the table as well. Responses have been grouped according to the place of articulation for the various groups of consonants for simplicity of presentation, so that a high frequency within the proper group does not necessarily mean a high frequency of correct perception. Consonant clusters have been grouped with single consonants according to the group to which the first member belongs, except for clusters preceded by s- which have been arbitrarily assigned to the group of the second member. Response percentages given refer to the number of usable responses, not to the possible totals of 106 and 113 for the full-face and profile views, respectively.

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[10] An experiment was conducted in the Speech Department, University of California, Los Angeles, in which subjects practiced lipreading through closed circuit television without sound. The material, unlike Film Test II, consisted of sentences, and three, rather than two, views were used. Mean scores were as follows: complete profile: .433; full-face: .589; 45 degree angle: .615. These are correct responses, but details of scoring were not given, nor was it stated whether the difference between the full-face and 45 degree angle was statistically significant (Larr, 1959).

TABLE 7

CONFUSION MATRIX: ALVEOPALATAL COMPARISONS

		Response Frequencies* %				
Item No.	Word	Dentals	Alveolars	Alveo-Palatals	Velars	Other
53.	SHOE	1	17 21	79 75	 2	2 2
50.	zoo		48 39	35 48	15 11	2 2
142.	YAWN	1	63 69	9 8	25 22	2 1
98.	thought	96 98	3 2			1
154.	dawn	1 1	42 45	54 52	3 2	
7.	CHIEF		10 12	79 82	11 6	1
179.	thief	71 77	19 20	2 2	7 1	1
195.	leaf	14 19	39 46	 2	47 31	 2
194.	JOB		10 16	89 82	1 2	
151.	SHOP		7 6	93 93	 1	
35.	top		93 93	 4	7 3	
159.	cop		10 10	1 1	89 89	

* The upper row of figures for each test item refers to the full-face view, the lower row to the profile view.

Examination of the Table indicates that the alveopalatal affricates and spirants (č, ǰ, š) appear to make up a visually-contrastive group, under both full-face and profile viewing conditions, when compared with the other groups of consonants mentioned. In no case does the correct perception of the alveopalatal group drop below 75% (shoe) and in one case it is 93% (shop). It will be noted, however, that alveolar consonants are frequently seen as alveopalatals, and in one case (dawn), a greater percentage of alveopalatal responses were given than alveolar ones. Further, when alveopalatals are not correctly identified by group, the incorrect responses are mostly alveolar ones. There are no significant confusions of alveopalatals with dentals, and in only one case (chief) do velar responses go above 10%.

While the semivowel y- was grouped with the other alveopalatal consonants here, it obviously does not join with them in forming a contrastive group. It is not evident in Table 7, but the other alveopalatals were seldom perceived as y-, and in turn, the small number of times that y- in yawn was perceived as an alveopalatal were almost all correct perceptions of y- itself. The majority of responses to y- in yawn were alveolar ones; on the other hand, dawn had fewer alveolar responses than alveopalatal ones, but d- was never perceived as y-.

The dental spirants proved to be even more easily perceived than the alveopalatal ones, and again, no significant differences with regard to view were noted. No separate table will be given here since the range of correct responses to the initial voiceless dental spirant (θ) may be found on Table 7: 71% for thief and 98% for thought. The voiceless member of the dental spirant pair, (θ-đ) was the only one tested since no monosyllabic nouns begin with đ-. Not only does θ- consistently show a high degree of correct perception by articulatory group (including words other than nouns beginning with đ- which were guessed, despite the fact that the subjects were told all test items were nouns), but only one other phoneme, l-, an alveolar, is perceived as a dental spirant with any frequency (see leaf in Table 7). In the items picked for comparison with the labiodental spirants (f-v), neither f- nor θ- dropped below 90% correct perceptions with regard to the proper group.

The final specific comparisons in the original view-angle hypothesis concerned the possibility of making distinctions within the alveopalatal group between the affricates (č-ǰ), the spirants (š-ž), and the semivowel (y-). The fact that y- is not confused with the other alveopalatals, nor they with it, has been discussed above. Beyond this, test results do not indicate any possibility of distinguishing between the affricates and spirants under either view.

Since the specific postulates for improved visual perception of certain initial consonants with a profile view of the speaker proved to be true for either view, the differences between Test I results (see Table 1) and those just given for Test II must be a function of other factors. Various possibilities will be discussed later in the report. A final attempt was made, however, to see whether any significant differences between the two views could be found. All instances of single initial consonants in the test were grouped and overall correct response percentages were derived. In this case, correct perception refers to the individual phoneme, without regard to articulatory group, and responses of consonant clusters containing the consonant in question were not counted as correct. The results of this check are summarized in Table 8. These figures cannot be considered to represent general probabilities for correct perception, since some initial consonants were presented only once or a few times, but the probabilities for the two views can be considered the same.

The information in this table demonstrates again that significant differences cannot be found between the two views: of the 21 initial consonants represented, 9 have better response percentages with a full-face view, and 10 with a profile view, but no pattern emerges which might indicate that one type or position of articulation benefits from either view. A similar test was run on the vocalic nuclei and again only random differences were found. From this, it appears that either a full-face or a 45 degree profile is equally good for lipreading purposes.[11]

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[11] After the profile film was shown to a group at the John Tracy Clinic, a tutor of the deaf was asked for her opinion of the profile view; she replied that she had not been aware that other than a full-face view had been used.

TABLE 8

PERCEPTION OF INITIAL CONSONANTS WITH DIFFERENT VIEW-ANGLE

Phoneme	Number of Test Items	Correct Response Frequencies %	
		Full-Face	Profile
p-	4	42	40
b-	16	52	51
w-	8	71	72
r-	16	49	52
f-	12	78	79
v-	1	15	14
θ-	6	63	74*
t-	11	14	16
d-	7	12	15
n-	2	4	4
l-	9	45	46
s-	9	38	36
z-	1	1	0
č-	5	43	40
ǰ-	3	29	22
š-	5	41	44
y-	3	28	21
k-	14	24	26
g-	4	1	2
h-	5	56	56
∅-	4	27	22

*The difference of 11 here is significant at the 5% level; however, the combined percentages for the voiceless-voiced pair of dental spirants (θ-đ) are 90 and 89, respectively, and it could not reasonably be postulated that the distinction between voiceless and voiced consonants could be made under either view.

II. PERCEPTIBILITY OF VOCALIC NUCLEI

It was postulated that the most important articulatory dimension for the visual perceptibility of vocalic nuclei would be the factor of lip position, in other words, whether the lips are extended or rounded. Further, lip position changes in the production of two English diphthongs, in one case (aw) from extended to rounded and in the other (ɔy) from rounded to extended. On the basis of these facts, four groups of vocalic nuclei were distinguished hypothetically, manifesting internal confusions when a group contained more than one member, but contrastive insofar as the group as a whole was concerned. This overall hypothesis was summarized in Table 6.

Four minimal (or nearly minimal) sets of test items were included to test this hypothesis: a complete set with an initial bilabial consonant and a final postlabial consonant, and three partial sets with an initial labiodental and a final postlabial, an initial alveolar and a final bilabial, and an initial glottal and final alveolar. (see Sec. II, Classification of Variables). A complete confusion matrix for the bilabial initial and postlabial final is presented as Table 9, utilizing data from the full-face view responses, and presented in the same form as Table 6 for easier comparison with the hypothesis.

While the internal confusions within groups i and ii do not follow the neat pattern hypothesized, the groups appear in general to be contrastive, with one possible exception. There is a significant number of central extended vowel responses to back rounded vowel stimuli, although a lower percentage was found with the full-face view. It will be noted, however, that even though the groups contrast with each other, the internal confusions are sometimes considerable and correct responses to individual vowel nuclei sometimes very low.

This is borne out further by a comparison of correct responses in the above minimal set with those for the partial sets, using full-face data. Table 10 presents this information, listing the percentage of correct identifications of the various vowel nuclei. It is readily apparent that the range for most of them is considerable; most striking, perhaps, is -ɔy-, which drops to 17%, so that it cannot be considered contrastive under all conditions.

TABLE 9

CONFUSION MATRIX: VOCALIC NUCLEI

Test Items	Response frequencies %													
	iy	i	ey	e	ä	ay	e	a	ɔy	aw	uw	u	ow	ɔ
biyt	73	23	1	1	2									
bit	46	20	3	7	2	1	19					1		
beyt	3	5	32	13	36	10	1						1	
bet	1	2	29	7	42	16	2						1	
bät			2		79	9	1	7	2	2				
bayt	4	3	24	11	10	28	13	4			1	1		
bes	10	3	22	6	4	21	32	2						
pat			1		12	9	3	65						10
bɔy			1		1				93			2	2	1
bawt										97				3
buwt	5	3					9			7	41	29	3	2
buk			1		1	1	18	2	6		4	63		4
bowt							1				11	14	71	2
bɔs	1			2	2		1	32	3				2	56

Lines separate visually contrastive groups according to hypothesis (cf. Table 6)

Unfortunately, since three of the minimal sets are incomplete it is impossible to say whether one of these consonant environments is better for the visual perception of vowels, or whether factors such as word frequency or expectancy are operating here. In any case, it is apparent that the visual perception of English vocalic nuclei must be dependent on other factors than visible facial movements resulting from lip and tongue movements during their articulation. This is a subject which may be clearer following further examination of the results of Test II. However, when the combined correct responses for all vocalic nuclei in test items were compiled in a check on the profile hypothesis, the same extreme ranges of correct response were encountered(and no consistent difference was found for the different views).

TABLE 10

CORRECT PERCEPTION OF VOCALIC NUCLEI IN DIFFERENT ENVIRONMENTS

Vocalic nuclei	Correct Response %			
	Bilabial-Postlabial	Labiodental-Postlabial	Alveolar-bilabial	Glottal-Alveolar
iy	73	72	47	--
i	20	32	--	55
ey	32	45	1	--
e	7	--	--	10
ä	79	--	68	--
ay	28	71	20	--
e	32	13	34	--
a	65	--	92	--
aw	97	--	--	97
ɔy	93	17	--	49
uw	41	93	96	69
u	63	--	--	49
ow	71	53	--	--
ɔ	56	84	--	83

Since American dialects of English are characterized by considerable vocalic variation, which is not always consistent, it is doubtful whether a picture of visual perception of English vocalic nuclei as clear as that emerging from test results for the consonants is possible. Nevertheless, future testing should certainly remove some of the ambiguities and apparent inconsistencies seen in the data above.

III. INITIAL CONSONANTS IN VARIANT VOCALIC ENVIRONMENTS

The classification of English initial consonants derived from the results of Test I was based entirely on the appearance of these consonants before the low central vowel -a·. In order to see whether this classification was in any way dependent on the selection of this vowel for the nonsense syllables of Test I, various minimal sets were included among the items for Test II in which representatives of the units established from earlier results preceded different vocalic nuclei.

It was postulated, however, that alterations of the following vowel would have no significant effect on the units already established. With one important qualification, this hypothesis proved to be correct. The qualification refers to the visual contrastiveness already established by Test II for the alveopalatals and dentals (see the discussion of the view-angle hypothesis above). The bilabials, labiodentals, and dentals, together with the rounded labials (w-r), achieved high correct response percentages with regard to their respective groups before -iy-, -uw-, -ɔ-, and -ə-. Internally, the usual random confusions were found, such as between p-, b-, and m-, or f- and v-.

Similarly, the alveopalatals also had almost identical correct scores of over 80% before -ɔ- and -ə- the only vowels before which they were tested, again high enough to assume visual contrastiveness. Three alveolar consonants were also tested in these sets, and here the correct response percentages fell very low. While 94% of the responses to s- were alveolars for the test item seed, only 39% of the responses to l- in leaf were alveolars. Responses to t- in tool and talk were 36% and 35% for alveolars, respectively. All figures given here are from the full-face view results, but profile view scores were similar. For these particular items nearly half of the responses were alveopalatal ones, showing the unreciporcal confusion discussed earlier. However, the wide variation in correct response for initial alveolar consonants does not seem to be consistently influenced by the following vowel, and other factors must be investigated to explain it.

IV. INCONSISTENT VISUAL UNITS FROM TEST I RESULTS

The visually contrastive unit f-v derived from Test I results showed certain inconsistencies, a confusion of f- with r-, and of v- with ð-. The unit was nevertheless regarded as distinctive since f- and v- contrasted with all other members of the other three units. Certain test items were selected to re-check these ambiguities under the different experimental conditions of Test II.

In the minimal pairs *reed-feed* and *rule-fool*, test results indicate no confusion between *r-* and *f-*, with the possible exception of *fr-* cluster responses. These ranged from 3% for *fool* to 21% for *feed*, full-face view, although no one gave *this* response for either *reed* or *rule*. Beyond this, *r-* was never perceived as *f-*, and *f-* was never perceived as *r-* alone, although *there* were 3% *r-*cluster responses for *fool*.

While the *v-ð* confusion could not be tested with these phonemes, *three* almost-minimal sets contrasting *f-* and *θ-* were included in the test. Comparing these responses, it *was* found that correct response percentages by group ranged from 93 to 100% for both *f-* and *θ-* under both view angles; while there were cases *where* one was guessed for the other, these guesses in no case equalled the random guesses giving other consonants or clusters.

Because objections had been raised concerning the group of *w-r* set up on the basis of the first test, three minimal pairs were included to test the possibility of visual discrimination within this group. Comparison of these responses is presented by means of a confusion matrix in Table 11.

TABLE 11

CONFUSION MATRIX: ROUNDED LABIAL CONSONANTS

Test Item	Word	Response Frequencies %				
		w-	C+w-	r-	C+r-	Other
33.	weed	72	26	1		1
125.	reed	43	31	17	8	1
99.	wing	61	36	2		1
116.	ring	31	21	38	10	
5.	witch	57	42	1		
174.	ridge	35	18	46		1

It is apparent from this table that *w-* was rarely perceived as *r-*, and that, counting responses giving consonant clusters with *w-* (the majority of which were *hw-*), it achieved a high percentage of correct responses. On the other hand, *r-*, even when clusters with *r-* were counted as correct perceptions, did not have a correct response percentage higher than 50. However, since the remaining responses to *r-* are almost entirely *w-* or clusters with *w-*, the grouping of the two consonants into a homophenous unit appears justified. The phenomenon of nonreciprocal confusions has already been encountered in the discussion of alveolar and alveopalatal consonants, and will be covered more thoroughly in the section on Test III.

SPEECH PERCEPTION STUDY - FILM TEST III

EXPERIMENTAL DESIGN

Stimulus units for Test I were presented as pairs of minimally-distinctive nonsense syllables, to the members of which subjects were asked to respond as "alike" or "different". As a result of these procedures, it was not possible to determine whether the confusions found were reciprocal.

In order to clarify the nature of the perceptual confusions suggested by the first experiment--as well as to provide additional data on the visual perception of speech units--the 25 consonant-initial allophones of English were re-tested under conditions which duplicated the linguistic controls and environments imposed for Test I, but which differed in testing and analytic procedures.

The 75 nonsense syllables (Ca.) of Test III were presented as a series of single stimulus units, and the task of the subject was to identify the initial consonant of each syllable. Use of the Ca· syllable was necessary here, as in the first experiment, to maintain the controls of a constant and non-redundant phonetic environment. The rationale for these controls, and for selection of the Ca· formula in these terms are discussed in the preliminary report of the study (Woodward, 1957, pp. 6-7).

Although the film was produced at the same time as Test II, the nonsense-syllable test was not a part of that experiment; i.e., it was not to be administered at the same time, nor to the same subjects, as the test which utilized lexical items as stimuli. It should be noted, however, that including this design in second-stage experimentation obviates the necessity of controlling at this level for idiosyncratic differences in articulation habits. Stimulus materials for all sections of Test II and Test III were presented by a single speaker.

The film script for the test is included as Appendix C to this report, and instructions given the subjects appear on the sample cover page reproduced as Appendix D.

RESULTS

While Test III was filmed at the same time as Test II, there was a considerable delay in delivery, and it was not received by the project staff until April, 1960. Arrangements were then made to show the full-face version to a phonetics class at the University of California, Los Angeles, in early May. When the film was shown, it was learned that one of the 75 views of the speaker uttering nonsense syllables was defective.

Despite these difficulties, 19 usable sets of responses were obtained from the instructor and 18 students. Since each initial consonant was presented three times, it was felt that one omission would not seriously distort the results. The syllable omitted was number 36, ða. Presenting the film to a phonetics class made it unnecessary to train subjects in phonemic transcription to indicate those consonants for which English spelling is ambiguous or inconsistent. Further, it provided a group which was interested in linguistic problems and which was used to thinking in terms of linguistic units.

The cover page for the answer sheets (Appendix D) listed the initial consonants included. This was necessary since nine of the nonsense syllables in the film script began with initial elements which do not normally appear initially in English words, or are not normally considered initial consonants: ž, W (usually phonemicized as the cluster hw-), and ø (simply a·, with no initial consonant.

The results of the test are presented below, according to visually-contrastive units which appear to be confirmed by the response patterns. It should be borne in mind that since each consonant was presented three times in the test with 19 subjects, there were 57 chances for a correct perception (except for ð-, the omitted consonant, for which only 38 chances for correct perception were possible). Correct perception for groups increase the total number of possible chances, according to the number of consonants included.

In comparison with the results of Test I, the data from Test III provide seven contrastive groups. These are listed below in order of percentage of correct perception;

confusions within each group are roughly proportional to the number of consonants included (except as noted below):

1.	p-b-m	96%
2.	f-v	92
3.	č-ǰ-š-ž	85
4.	W-w-r	82
5.	θ-đ-l	71
6.	k-g-h-Ø	70
7.	t-d-n-s-z-y	63

Groups 1, 2 and 4 correspond to units derived from Test I results. Groups 3, 5, 6, and 7, however, contain consonants which were grouped together in earlier results. The possibilities for distinguishing between members of the large group of nonlabial consonants, labeled group 4 in Test I results, appear to be confirmed by Test II results (see the discussions of the view-angle hypothesis and the inconsistent visual units). Whether this means that too rigid requirements for visual contrastiveness were used in the analysis of Test I results, or whether the difference in presentation of the nonsense syllables in Test III somehow improves the chances for correct visual discrimination has not yet been investigated.

One point remains to be discussed, however, concerning the placement of certain initial consonants in the listing just given. The problem of nonreciprocal confusion has already been mentioned with regard to r- and w- and the alveolars and alveopalatals. The relationship of r- and w- in Test III results is very similar to that discussed for Test II: while r- is frequently perceived as w-, the reverse does not take place. In Test III results, the same is true of l- and the dental spirants. Other unequal confusions are found in the alveolar group; n- was perceived as velar just as often in this sample as it was as an alveolar. In addition, the semivowel y-, classified as an alveopalatal, had more alveolar responses than any other kind, almost 50%. On the contrary, only three subjects identified any of the 75 initial consonants in the test as y-, none of the responses being correct (once each g-, h-, and Ø-).

This same phenomenon may be noted with m-, highly visible with only two other consonants with which it may readily be confused. In Test III results, however, m- was identified as p- or b- 88% of the time, while p- and b- were rarely identified as m-. Related to this problem, perhaps, is the fact that combined responses to all the voiceless-voiced pairs in Test III showed higher frequencies for the voiceless member of the pairs. Thus, p-, f-, θ-, t-, s-, č-, š-, and k- were all represented in the response frequencies a greater number of times than their voiced counterparts. Tests of statistical significance have not yet been run, but in some cases they are obviously unnecessary, such as 80% of f- responses, as opposed to 12% v- responses, for the combined total of 114 chances to perceive a labiodental spirant, without regard to voicing. (This corresponds with the responses in Test II to item 96. voice, which was identified by most subjects as 'force', despite the fact that -oy- in other words is identified correctly over 90% of the time.) While the preference for voiceless consonants in test responses may be due to the fact that the subjects are seeing the films without sound, there may be some unknown factors of phoneme expectancy present. Analysis of control data for Test II, and the showing of Test III with sound, may provide the answer.

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5. LANGUAGE ACQUISITION STUDY

RESEARCH DESIGN

Because of the order of patterning universally characteristic of linguistic phenomena--i.e., the partial recurrences of elements in a larger linguistic pattern--it can be said that an individual never actually "learns" all the possible utterances of his native language. In fact, he probably learns very few of them in the classical sense; rather he infers the patterns and fabricates utterances on the basis of what he hears.

The nature of the learning processes implied in the character of language, and in the fact of speech acquisition by the human infant, is extremely important to long range research into problems of the aurally handicapped individual. Assuming that the deaf child is otherwise capable of the sort of implicit analysis which is evident in human communication, then a principal aim of applied research in this field might well be the attempt to develop techniques for activating these latent processes of language learning. Given this ultimate objective, a major question is: How can we bridge the gap from (i) the discrete conditioning practices necessary in the tutoring situation, to (ii) the sort of pattern-learning and utterance-creation which seem to arise almost spontaneously in the aurally normal child?

In a survey of educational research problems of language development,[12] it is stated that "oddly enough, one never seems to think of 'teaching' a child to learn language in the early phases, or of investigating the effects of specific practices in such teaching." Congenitally deaf children, however, can acquire speech and language only by such teaching practices. Institutions for the deaf which include a nursery school program, then, provide both subjects and setting for such a study as Carroll suggests.

It was planned to supplement the perception studies by utilizing the linguistic model as a guide for observations and testing of language development in the aurally handicapped child.

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[12] John B. Carroll, Language Development in Children, prepared for the Encyclopedia of Educational Research, 1960.

The immediate goal for this phase of the 18-month project was the construction and pre-testing of a design for an intensive study of language learning in deaf children. The ultimate goal planned for this research is a systematic description of the characteristics of language learning and speech development in the pre-school and elementary-school deaf child. Developmental sequences derived in this way can be the basis for comparisons of the linguistic behavior of deaf and normal-hearing children, and the results of such comparisons can then be used in assessing specific tutoring techniques current in education of the deaf.

As an example of the data to be collected according to the levels and categories characteristic of the English language, the general question was raised: How does the linguistic behavior of the deaf child differ from that of the normal child, and to what extent are these differences a function solely of hearing loss? Alternatively, are the characteristic differences attributable in part to the nature of the tutoring situation--structured in terms of language learning--and to the institutional segregation of deaf children even in those activities which are not structured as to linguistic experiences?

Phrased more specifically in terms of the linguistic model, and with reference to teaching practices peculiar to schools for the deaf, the long-range goals of the project might be expressed in the following sample questions:

1. Phonological - What is the sequence of articulatory development in the deaf child, as compared to the normal child?
    - a. How do these differences relate to pilot experiment findings on the perceptibility of English consonantal articulations?
    - b. How and to what extent is the low visibility of the majority of consonantal articulations compensated for by combined visual-tactile-auditory techniques of teaching (i.e., lip reading, feeling articulatory movements, and amplification of residual hearing)?
2. Grammatical - What is the characteristic structure of the expression system of the deaf child, and how does this relate to different teaching practices in education of the deaf? (For example, does discrete conditioning to isolated vocabulary items--typical of some tutoring procedures--manifest itself in an atomistic form of expression in the deaf child?)

3. **Lexical** - How does the extent of reference of lexical items within the deaf child's comprehension range compare with semantic areas typical of the normal child's vocabulary? How does this difference relate to the situation-word approach typical of some tutoring practices?

It was initially planned that data for a developmental description of the linguistic behavior of the aurally-handicapped child were to be derived primarily from a program of naturalistic observations of pre-school deaf children, conducted in terms of the levels and categories of the linguistic model. Extensive observations of tutoring sessions at the John Tracy Clinic (along with a survey of Clinic records and tutor's reports of the children observed) made it clear, however, that the data necessary for the research objectives of this study could not be obtained by observational techniques alone. Tutoring sessions proved to be too restricted in purpose to provide the selective range of behaviors necessary to the descriptive aims outlined above, even though the initial goal prescribed a test only of phonological aspects of language learning and speech development.

For these reasons, it was decided to accelerate the research schedule, and to introduce certain experimental techniques not initially planned for the 18-month project. Although observations and records continue to be a part of the program, these are no longer considered as the primary source of data for the linguistic descriptions to be formulated. In order to supplement these techniques, then, the project was redirected toward the development and pre-testing of a series of eliciting procedures and discrimination tests, designed to provide systematic information about the expressive and perceptual aspects of phonological development in the pre-school deaf child.

Subjects of the study have been drawn primarily from the John Tracy Clinic Demonstration Nursery School, which has an enrollment of 22 deaf children from 2-6 years of age. Observation and testing began with senior students (i.e., those with three years of training), and will proceed during the continuation program to successively-younger children until all test levels have been administered to the entire roster of students. Follow-up studies of elementary school children will also be made by testing Clinic graduates and other deaf children from 7-9 years of age. It is hoped that samples of 20-25 children at each age level can be tested, making a total of approximately 75 subjects. By this series of procedures, information will be obtained on the developmental stages of linguistic behavior in a single group of children for the duration of the three-year continuation project.

Control data will be derived primarily from comparable studies of normal-hearing children as reported in the literature. Principal source for the comparative data will be Mildred C. Templin, *Certain Language Skills in Children*.

As a technique to determine the phonological distinctions made by the aurally-handicapped child, both in perception and articulation, preliminary tests in the series present sets of minimally-different lexical items based on the tentative categories of visual difference established in the experimental studies of lipreading. Though the testing of aurally-handicapped children has not yet been extensive enough to allow statistical controls minimizing factors of chance, pre-tests of eliciting procedures have raised the possibility of a greater visual discriminability among certain phonological features than seemed to be indicated in perception experiments with *untrained* normal-hearing adults. For this reason, subsequent test materials for the language acquisition study will ultimately duplicate the articulatory distinctions tested in the speech perception experiments.

Test items have been selected in terms of the vocabulary comprehension standard for pre-school deaf children, and are restricted to those words or word-combinations which can be represented easily in pictures, or in presentations of the objects themselves.

The principal technique for tests of perceptual and articulatory discrimination consists of the presentation of a set of paired pictures (or objects) along with a *verbal* stimulus designating one of the two pictures shown. The task of the child is to select (by pointing or speaking) the picture appropriate to the word spoken by the examiner. The subject must select, for example, between "fish"and "dish (a comparatively easy lipreading distinction), or between "cat" and "hat" (an articulatory difference which, in nonsense-syllable tests, was shown to be virtually impossible to perceive by visual cues alone).

Though testing thus far seems to indicate that a large amount of stimulus material does not strain the achievement level or the tolerance range of the advanced student, it is obvious that the number of test items per trial must be restricted for younger children. A typical first-year student (2 years old) does not have a large lipreading vocabulary, and is not yet equipped to acquire new lipreading words simply by virtue of the test experience. To minimize the effect of guessing, each subject will, on separate occasions, undergo a minimum of three trials of each test, the trial sets differing only in the arrangement of alternative pictures with verbal stimuli.

Each test in the series will be constructed to account for a limited number of variables at one of the three levels of the theoretical model (phonological, lexical, grammatical), and the selection of stimulus materials for each subsequent test will be made in terms of the results at the preceding test level. This procedure not only assures that the resulting descriptions of language development can be stated in linguistic terms, but will also permit the investigation of discrete developmental problems and, consequently, a point-by-point comparison of results with the linguistic behavior of normal-hearing children. The first discrimination test in the phonological series is discussed in the following section of this report.

PERCEPTUAL DISCRIMINATION TEST I

The pre-tests and initial testing described here were conducted to develop procedures for eliciting responses from pre-school deaf children, and were not intended primarily to provide substantive data for analysis of visual perception at this level of investigation.

After pre-testing of a 40-item test with older children, ten items were selected from the larger test for use with John Tracy Clinic Demonstration Nursery School students. The 10-item test was designated Perceptual Discrimination Test I, since there will be further tests of this nature, as well as articulatory discrimination tests, in the continuation program.

Data given in this discussion were collected from the administration of three trials of the 10-item perceptual discrimination test to each of 21 Nursery School children whose ages ranged from 2 years 9 months to 6 years at the time testing was started. Using the techniques described in the preceding section, a trained tutor of the deaf presented the test items to the student being examined, while members of the research staff recorded responses in an observation room equipped with a one-way mirror.

Stimuli presented in the three trials of Test I are listed in Table 12, which also shows the results of this test. Test items are presented in order of perceptibility, as determined by the percentage of correct responses of 63 possible correct choices. As examination of the table shows, the consonantal contrasts presented as word-initials in the paired stimuli were based on the tentative homophene classes derived from Film Test I of the speech perception study. Subsequent discrimination tests for the language learning project will be designed in terms of the alignment of vocalic and consonant-final homophenes already suggested by Film Test II.

It should be noted that the results of the testing with children have so far been consistent with the results of the pilot experiment (cf. Table 1), though the degree of discrimination was in each case higher than would have been predicted on the basis of Film Test I data alone.

TABLE 12

PERCEPTUAL DISCRIMINATION TEST I

Item No.	PICTURED CHOICES	VERBAL STIMULUS			CORRECT CHOICES %
		Trial 1	Trial 2	Trial 3	
5.	ball - man	man	ball	man	89
7.	fish - dish	fish	dish	fish	87
1.	boat - coat	boat	coat	coat	84
4.	bed - red	bed	red	bed	81
9.	car - cow	cow	car	car	81
10.	man - moon	moon	man	moon	81
2.	milk - moon	milk	milk	moon	76
6.	cake - cat	cake	cake	cat	54
8.	cat - hat	hat	cat	hat	54
3.	jump - cup	cup	jump	jump	51

6. SUMMARY

With the ultimate goal of improving techniques for teaching the deaf and hard of hearing, the methods of modern structural linguistics are being used in a continuing investigation of two aspects of this problem: 1) communication techniques: to define the character of speech in perceptual terms, with emphasis on visual speech reception (lipreading); and 2) education techniques: to examine the processes of induced language learning in deaf children.

The study reported here was conducted primarily to develop a long-range research program in which the present 18-month project would constitute a pilot investigation in the application of linguistic methodology to the problem areas concerned. On the basis of this pilot study, a comprehensive research design has been constructed for a three-year program to be supported by funds from the Office of Education, U. S. Department of Health Education, and Welfare.

While the two areas of research outlined above require different investigative procedures, the conceptual framework for both phases of the project derives from a linguistic model (Woodward, 1957). Investigation proceeds according to the customary levels and categories of linguistic analysis: 1) Phonological (phonetic, phonemic, syllabic, morphophonemic); 2) Grammatical (morphological and syntactic); and 3) Lexical. More specific application of the analytic model will be discussed separately for the two phases of the program.

Speech Perception Study

The study of communication techniques has the following objectives: 1) to develop a theoretical model for the structure of perception in lipreading, i.e., a tentative definition of the units of visual perception of oral-aural stimuli, and the relationships among these units in a system of oral-visual communication; and 2) to establish the relationship of the visually perceived symbols to the oral-aural model, i.e., between the visual perceptibility of speech and the underlying linguistic system.

The principal technique used in achieving these goals is construction of a series of film tests designed for administration without sound to a sample population of normal-hearing adult speakers of English. Presenting the sound track alone and the sound track plus film to smaller groups provides auditory and audiovisual controls for the experimental data. Three such tests have so far been produced and administered in the present investigation, though the pilot experiment of the series (designated Film Test I) was conducted before the beginning of the Cooperative Research Project reported here.[13]

The administration of Film Test II, a series of 198 monosyllabic English nouns, to 219 subjects, and with sound or with sound track alone to 209 control subjects, has produced much new data on the perception of English phonemes in lipreading. As originally planned, all of the subjects were normal-hearing adults, with no prior training in lipreading. Since the film was made with both a full-face view and a 45 degree profile view it was possible to compare the chances for correct perception with differing facial views. The full-face version was seen by 106 subjects, and the profile version by 113. Examination of the data so far indicates that the two views are equally good for lipreading purposes, and that the hypothesized distinctions possible under profile view conditions can be made under either view.

This information, together with other comparisons made possible by selecting minimally-distinctive sets for the test items, provides a clearer picture of the perception of English initial consonants than was provided by Film Test I. The 22 initial consonants of English appear to fall into at least seven visually contrastive units, rather than the four which were derived from Test I data, a finding confirmed by the administration of Test III on a limited scale.

Data from Test II also provides the first experimentally-derived information on the visual perception of English vocalic nuclei. The 14 simple vowels and diphthongs of Midwestern American English appear to fall into four visually contrastive groups, although the divisions are not as clear cut as they are with initial consonants. However, further examination of the data may reveal a greater number of possible distinctions, and in any case, will point out areas for future testing.

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[13] The investigation using Film Test I was supported in part by the Office of Vocational Rehabilitation, U. S. Department of Health, Education, and Welfare, and in part by the John Tracy Clinic. Results are summarized in Table 1 of this report, and the research is described more fully in Woodward, 1957, and Woodward and Barber, 1960.

Results from Test II will be analyzed further with regard to initial consonant clusters and final consonants, so that future testing will be based on more complete information concerning the visual perception of English phonemes in monosyllabic utterances.

The administration of Film Test III without sound has provided data for comparison with both Test I and Test II results. While, like Test I, it consisted of nonsense syllables and can provide data only on the visual perception of English initial consonants, results from Test III indicate that a greater number of phonemic distinctions may be made by a lipreader among these consonants than Test I data indicated. Since this agrees with Test II findings, the number of visually contrastive units of English initial consonants can probably be expanded.

The internal consistency of responses to Tests II and III demonstrates the relevance and value of a linguistic model for the investigation of lipreading. While the hypotheses employed in many cases were proved wrong, in whole or in part, it is highly significant that normal-hearing speakers of English, with no training in lipreading, tend to agree in their responses to utterances presented to them without sound in the film tests described.

Language Acquisition Study

The primary goal of the initial language learning investigation was the design of a long-range study leading to a systematic description of the linguistic behavior of the pre-school deaf child, a comparison of linguistic development in the deaf and normal-hearing child, and finally, a linguistic evaluation of methods current in the education of aurally-handicapped children, allowing for a specific program of suggestions for the improvement of lipreading techniques and methods of teaching the deaf.

As originally planned, the investigation of education techniques was to be primarily descriptive in nature, based on intensive observations of linguistic behavior in pre-school and elementary school deaf children. As a means of determining the methods which substitute for the processes by which normal-hearing children learn to speak, a series of observations--phrased in terms of the principal categories of the linguistic model--was conducted at the John Tracy Clinic Demonstration Nursery School. Because these observational techniques proved inadequate to the goals of the language acquisition study, it was decided to institute experimental procedures comparable to those being used in the speech perception investigation.

The first tests of this experimental series were designed to provide information about the expressive and perceptual aspects of phonological development in the pre-school deaf child. As an example of these techniques, preliminary tests present sets of minimally-distinctive lexical items based on the tentative categories of visual difference established in the studies of lipreading. (Test materials of the language acquisition study will ultimately duplicate the articulatory distinctions tested in the speech perception experiments).

The principal technique used for tests of perceptual and articulatory discrimination in pre-school deaf children consists of the presentation of a set of paired pictures (or objects) along with a verbal stimulus designating one of the two pictures shown. The task of the child is to select the picture appropriate to the word spoken by the examiner. Each test in the series will be constructed to account for a limited number of variables at one of the three levels of the theoretical model (phonological, lexical, grammatical), and the selection of stimulus materials for each subsequent test will be made in terms of the results at the preceding test level.

As a means of developing eliciting procedures appropriate to the long-range research program, Perceptual Discrimination Test I was constructed and administered to 21 nursery school students at the John Tracy Clinic. The techniques described above were utilized and found adequate for working with pre-school deaf children.

Although the tests with children must be shorter and more frequent than the experiments conducted using adult subjects, it is perhaps interesting to note that the results of testing thus far have proved consistent with those derived in the speech perception project.

APPENDIX A

Script for Film Test II

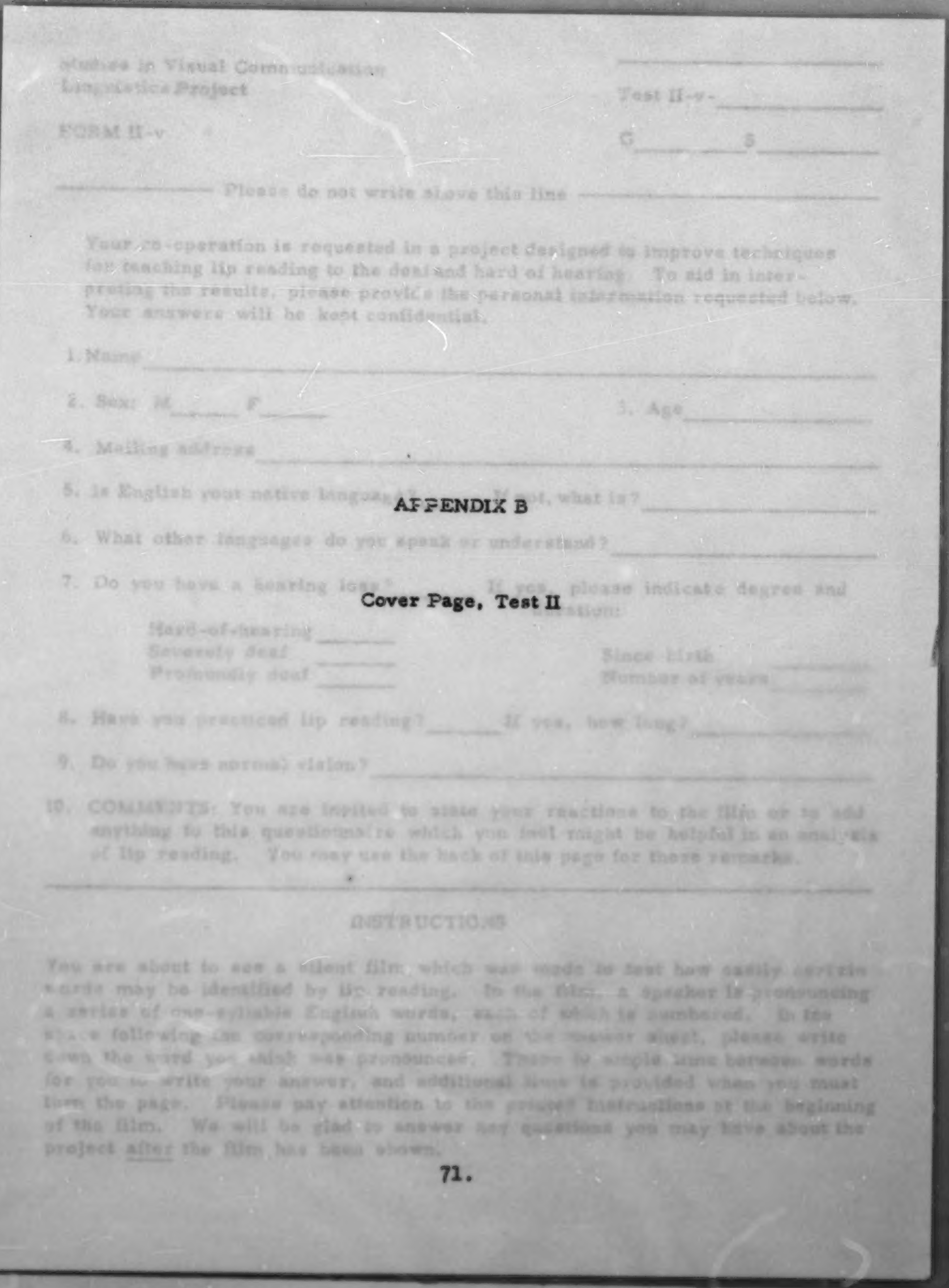
1. squeeze
2. grass
3. price
4. song
5. witch
6. wrech
7. chief
8. boot
9. glass
10. spree
11. deer
12. sign
13. fog
14. wick
15. glide
16. cone
17. rule
18. door
19. shred
20. speed
21. foot
22. rain
23. rose
24. fate
25. fig
26. leech
27. load
28. sphere
29. head
30. thing
31. sneeze
32. roof
33. weed
34. gear
35. top
36. bus
37. wool
38. thug
39. cue
40. sum
41. prose
42. slide
43. pot
44. wheat
45. spool
46. date
47. gum
48. rouge
49. pose
50. zoo
51. twitch
52. breed
53. shoe
54. fight
55. nap
56. goose
57. hall
58. scheme
59. freight
60. chin
61. dog
62. siege
63. bid
64. mule
65. tweed
66. seer
67. cot
68. sieve
69. tube
70. ear
71. fawn
72. butte
73. spine
74. tape
75. bet
76. year
77. king
78. loom
79. chum
80. gas

81. seed
82. bait
83. wake
84. flight
85. soup
86. loaf
87. shawl
88. splice
89. hue
90. seam
91. ditch
92. bat
93. cane
94. book
95. stream
96. voice
97. quack
98. thought
99. wing
100. hooch
101. wreath
102. lick
103. thong
104. tin
105. dough
106. brute
107. niece
108. bloom
109. dream
110. coat
111. stool
112. prize
113. shed
114. coal
115. thread
116. ring
117. fudge
118. fin
119. quake
120. kick
121. tug
122. boy
123. grain
124. bite
125. reed
126. fuel
127. rug
128. cake
129. pile
130. key
131. blight
132. tab
133. tooth
134. bout
135. cream
136. tool
137. fear
138. walk
139. fright
140. click
141. gin
142. yawn
143. code
144. talk
145. train
146. you
147. type
148. boss
149. room
150. feed
151. shop
152. broom
153. beet
154. dawn
155. lamb
156. team
157. boat
158. light
159. cop
160. bill

161. school
162. ream
163. trick
164. owl
165. queen
166. leash
167. bin
168. throng
169. wig
170. ski
171. oil
172. suite
173. eye
174. ridge
175. scream
176. bread
177. bit
178. fool
179. thief
180. cheer
181. thumb
182. car
183. reef
184. shin
185. cow
186. root
187. wrong
188. pool
189. chalk
190. steam
191. judge
192. call
193. hill
194. job
195. leaf
196. hood
197. phone
198. smear

APPENDIX B

Cover Page, Test II



Studies in Visual Communication
Linguistics Project

FORM II-v

Test II-v- ____

G ____ S ____

Please do not write above this line

Your co-operation is requested in a project designed to improve techniques for teaching lip reading to the deaf and hard of hearing. To aid in interpreting the results, please provide the personal information requested below. Your answers will be kept confidential.

1. Name ____
2. Sex: M ____ F ____ 3. Age ____
4. Mailing address ____
5. Is English your native language? ____ If not, what is? ____
6. What other languages do you speak or understand? ____
7. Do you have a hearing loss? ____ If yes, please indicate degree and duration:

Hard-of-hearing ____
Severely deaf ____
Profoundly deaf ____

Since birth ____
Number of years ____

8. Have you practiced lip reading? ____ If yes, how long? ____
9. Do you have normal vision? ____
10. COMMENTS: You are invited to state your reactions to the film or to add anything to this questionnaire which you feel might be helpful in an analysis of lip reading. You may use the back of this page for these remarks.

INSTRUCTIONS

You are about to see a silent film which was made to test how easily certain words may be identified by lip reading. In the film, a speaker is pronouncing a series of one-syllable English words, each of which is numbered. In the space following the corresponding number on the answer sheet, please write down the word you think was pronounced. There is ample time between words for you to write your answer, and additional time is provided when you must turn the page. Please pay attention to the printed instructions at the beginning of the film. We will be glad to answer any questions you may have about the project _after_ the film has been shown.

Studies in Visual Communication
Linguistics Project

FORM II-v

____

Test II-v-______________

G__________ S__________

—————— Please do not write above this line ——————

Your co-operation is requested in a project designed to improve techniques for teaching lip reading to the deaf and hard of hearing. To aid in interpreting the results, please provide the personal information requested below. Your answers will be kept confidential.

1. Name____

2. Sex: M______ F______ 3. Age______________

4. Mailing address______________________________________

5. Is English your native language?______ If not, what is?______________

6. What other languages do you speak or understand?______________

7. Do you have a hearing loss?______ If yes, please indicate degree and duration:

Hard-of-hearing ______
Severely deaf ______
Profoundly deaf ______

Since birth ______
Number of years ______

8. Have you practiced lip reading?______ If yes, how long?______________

9. Do you have normal vision?______________________________

10. COMMENTS: You are invited to state your reactions to the film or to add anything to this questionnaire which you feel might be helpful in an analysis of lip reading. You may use the back of this page for these remarks.

INSTRUCTIONS

You are about to see a silent film which was made to test how easily certain words may be identified by lip reading. In the film, a speaker is pronouncing a series of one-syllable English words, each of which is numbered. In the space following the corresponding number on the answer sheet, please write down the word you think was pronounced. There is ample time between words for you to write your answer, and additional time is provided when you must turn the page. Please pay attention to the printed instructions at the beginning of the film. We will be glad to answer any questions you may have about the project after the film has been shown.

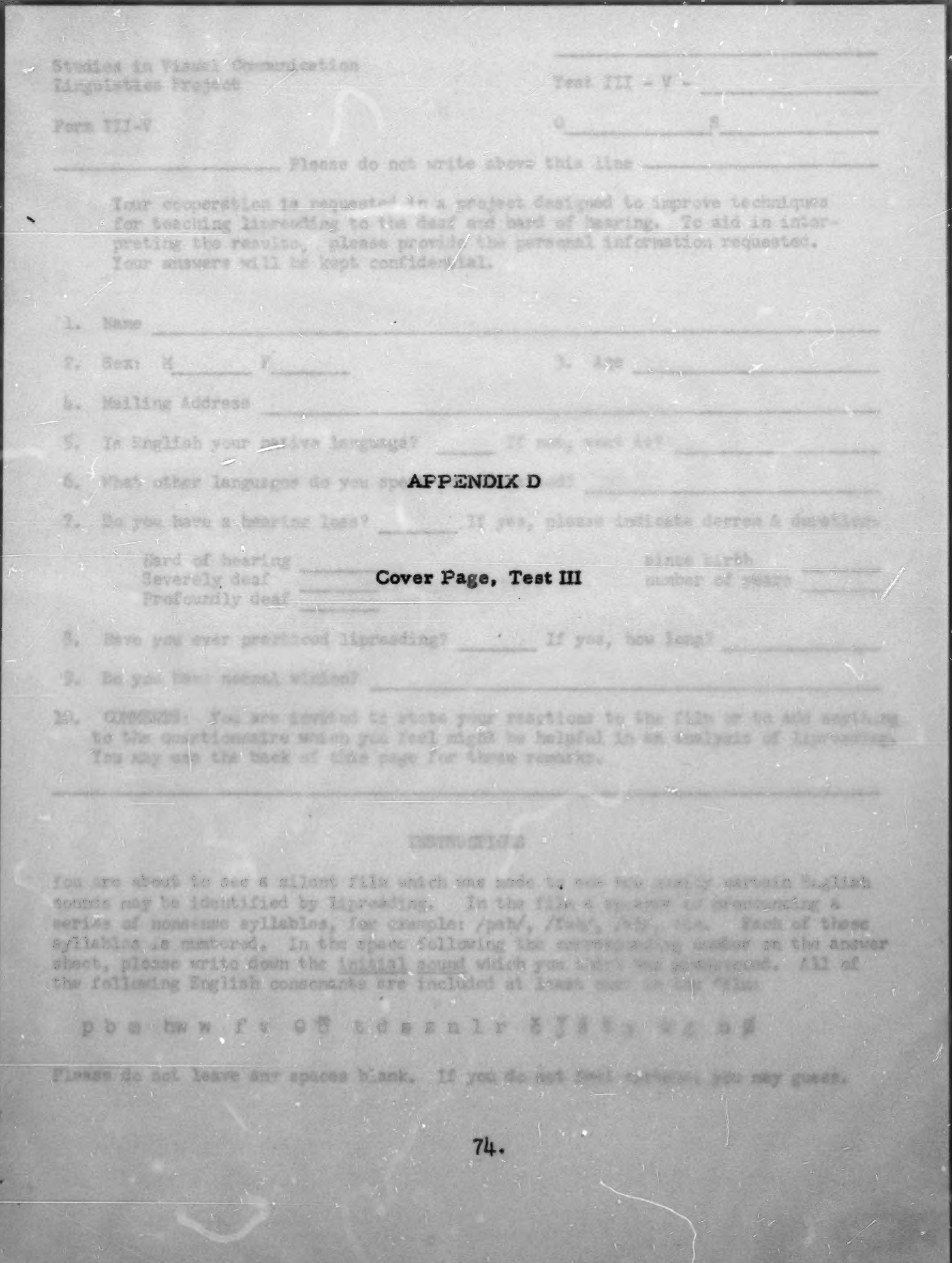
APPENDIX C

Script for Film Test III

1. la
2. ča (cha)
3. na
4. ya
5. va
6. ha
7. ǰa (ja)
8. θa (tha)
9. aa
10. ra
11. da (tha)
12. ša (sha)
13. aa
14. da
15. ta
16. ča (cha)
17. wa
18. θa (tha)
19. Wa (wha)
20. da
21. ra
22. ža (zha)
23. na
24. ǰa (ja)
25. va
26. ya
27. ba
28. Wa (wha)
29. ga
30. za
31. wa
32. la
33. ǰa (ja)
34. ta
35. fa
36. da (tha)
37. ka
38. za
39. wa
40. θa (tha)
41. ba
42. ča (cha)
43. la
44. ga
45. ša (sha)
46. da
47. ya
48. sa
49. ma
50. fa
51. ka
52. ba
53. pa
54. va
55. ha
56. na
57. ra
58. ža (zha)
59. pa
60. ma
61. ga
62. fa
63. pa
64. aa
65. sa
66. ša (sha)
67. ža (zha)
68. ma
69. Wa (wha)
70. da (tha)
71. ka
72. za
73. sa
74. ta
75. [illegible]

APPENDIX D

Cover Page, Test III



Studies in Visual Communication
Linguistics Project

Form III-V

Test III - V - ____________

O ____________ S ____________

______________ Please do not write above this line ______________

Your cooperation is requested in a project designed to improve techniques for teaching lipreading to the deaf and hard of hearing. To aid in interpreting the results, please provide the personal information requested. Your answers will be kept confidential.

1. Name ______________________________
2. Sex: M ______ F ______ 3. Age ______________
4. Mailing Address ______________________________
5. Is English your native language? ______ If not, what is? ______________
6. What other languages do you speak [illegible]? ______________
7. Do you have a hearing loss? ______ If yes, please indicate degree & duration:

   Hard of hearing ______ since birth ______
   Severely deaf ______ number of years ______
   Profoundly deaf ______

8. Have you ever practiced lipreading? ______ If yes, how long? ______________
9. Do you have normal vision? ______________________________
10. COMMENTS: You are invited to state your reactions to the film or to add anything to the questionnaire which you feel might be helpful in an analysis of lipreading. You may use the back of this page for these remarks.

____

INSTRUCTIONS

You are about to see a silent film which was made to see how easily certain English sounds may be identified by lipreading. In the film a speaker is pronouncing a series of nonsense syllables, for example: /pah/, /fah/, [illegible], etc. Each of these syllables is numbered. In the space following the corresponding number on the answer sheet, please write down the initial sound which you think was pronounced. All of the following English consonants are included at least once in the film:

p b m hw w f v θ ð t d s z n l r č ǰ š ž y k g h ŋ

Please do not leave any spaces blank. If you do not feel certain, you may guess.

Studies in Visual Communication
Linguistics Project

Form III-V

____

Test III - V - ____________

G__________S__________

__________ Please do not write above this line __________

Your cooperation is requested in a project designed to improve techniques for teaching lipreading to the deaf and hard of hearing. To aid in interpreting the results, please provide the personal information requested. Your answers will be kept confidential.

1. Name ______________________________
2. Sex: M_____ F_____
3. Age __________
4. Mailing Address ________________________
5. Is English your native language? _____ If not, what is? __________
6. What other languages do you speak or understand? __________
7. Do you have a hearing loss? _____ If yes, please indicate degree & duration:

   Hard of hearing _____
   Severely deaf _____
   Profoundly deaf _____

   since birth _____
   number of years _____
8. Have you ever practiced lipreading? _____ If yes, how long? __________
9. Do you have normal vision? ____________________
10. COMMENTS: You are invited to state your reactions to the film or to add anything to the questionnaire which you feel might be helpful in an analysis of lipreading. You may use the back of this page for these remarks.

INSTRUCTIONS

You are about to see a silent film which was made to see how easily certain English sounds may be identified by lipreading. In the film a speaker is pronouncing a series of nonsense syllables, for example: /pah/, /fah/, /ah/, etc. Each of these syllables is numbered. In the space following the corresponding number on the answer sheet, please write down the initial sound which you think was pronounced. All of the following English consonants are included at least once in the film:

p b m hw w f v θ ð t d s z n l r č ǰ š ž y k g h ∅

Please do not leave any spaces blank. If you do not feel certain, you may guess.

APPENDIX E

Data Sheet, Test II

Total Responses:	Total Rejects:	O:	AS:	P:	Total different words guessed:

p________
b________
m________
w________
r________
f________
v________
θ________
đ________
t________
d________
n________
l________
s________
z________
č________
ǰ________
š________
y________
k________
g________
h________
ø________

pr________
pl________
br________
bl________
fr________
fl________
θr________
θw________
tw________
tr________
dr________
šr________
kw________
kr________
kl________
gr________
gl________
hw________

py________
by________
my________
fy________
vy________
ky________
hy________

sp________
spr________
spl________
sm________
sw________
sf________
st________
str________
sn________
sl________
sk________
skw________
skr________

iy________
i________
ir________
ey________
e________
er________
æ________
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ər________
ay________
a________
aw________
ar________
uw________
u________
ur________
ow________
ɔy________
ɔ________
ɔr________

p________
b________
m________
f________
v________
θ________
đ________
t________
d________
n________
l________
s________
z________
č________
ǰ________
š________
ž________
k________
g________
ŋ________
ø________
CC+________
CC-________

TOTAL:

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